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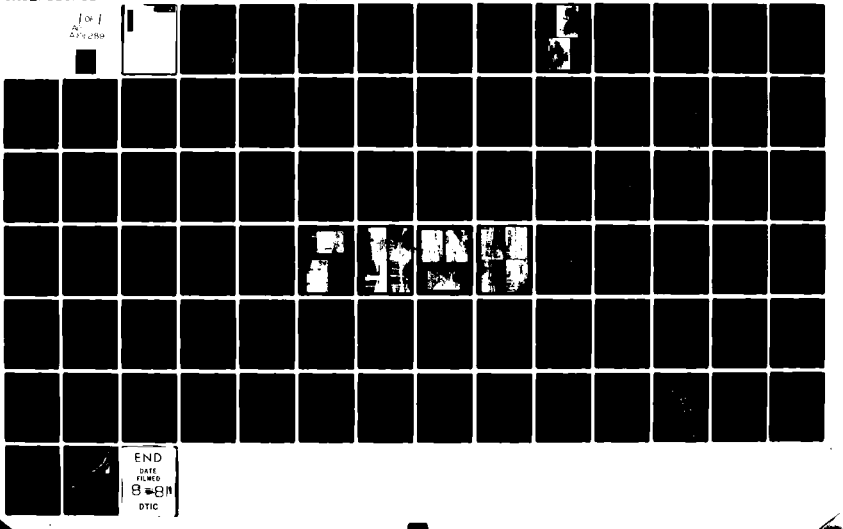

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SUSQUEHANNA RIVER BASIN

BUTTERMILK CREEK, LACKAWANNA COUNTY,

PENNSYLVANIA

FORDS LAKE DAM

NDI ID No. PA-00298
DER ID No. 35-064

PENNSYLVANIA FISH COMMISSION

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program. Fords Lake Dam (NDI ID Number PA-00298, DER ID Number 35-64), Susquehanna River Basin, Buttermilk Creek, Lackawanna County, Pennsylvania. Pennsylvania Fish Commission. Phase I Inspection Report.

Prepared by

GEO-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 South 19th Street
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Contract DACW31-81-C-0019

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For

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
Baltimore, Maryland 21203

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May 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expediously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Fords Lake Dam NDI ID No. PA-00298 DER ID No. 35-64
Size:	Small (10.7 feet high, 295 acre-feet)
Hazard Classification:	High
Owner:	Pennsylvania Fish Commission Robinson Lane Bellefonte, Pennsylvania 16823
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Buttermilk Creek
Date of Inspection:	December 8, 1980

Based on available records, past performance, visual inspection, field survey and calculations, the Fords Lake Dam is judged to be in poor condition. Based on the size and hazard classification of the dam, the recommended Spillway Design Flood (SDF) varies from a flood magnitude of 1/2 PMF (Probable Maximum Flood) to the full PMF. The 1/2 PMF is selected as the SDF based on downstream conditions. The present spillway capacity is limited to approximately 1% of the PMF. It is judged that the dam could not withstand overtopping by flows corresponding to the 1/2 PMF without damages or failure. Failure of the dam would create an increased hazard to property and to loss of life downstream. In accordance with the criteria established for these studies, the spillway is rated as seriously inadequate and the dam is classified unsafe, non-emergency.

In addition to a seriously inadequate spillway, other conditions exist that are potentially hazardous to the dam's stability. These conditions include:

Concentrated seepage at various locations.

Surface depressions apparently caused by internal erosion.

FORDS LAKE DAM

Lateral displacement of the downstream masonry wall.

Deteriorated spillway walls.

Possible undermining of the spillway slab.

The lack of functional outlet works precludes drawdown of the reservoir during emergencies. The present maintenance of the dam is considered to be unsatisfactory.

The following investigations and remedial measures are recommended to be undertaken by the owner immediately. The items are listed in approximate order of priority.

(1) Perform additional studies to ascertain more accurately the required spillway capacity and implement the necessary corrective actions.

(2) Perform investigations to determine the subsurface foundation and embankment conditions relative to the indicated internal erosion problems and the structural stability of the dam. These investigations should include monitoring of the seepage quantity and turbidity. Design and construct remedial measures as necessary.

(3) Perform temporary repairs to the existing spillway walls to prevent embankment erosion until an adequate spillway is constructed.

(4) Provide a method for drawdown of the lake.

(5) Provide additional erosion protection along the upstream crest of the dam to prevent wave erosion.

(6) Fill the subsidence depression and groundhog holes on the dam crest.

(7) Until the investigations recommended above are complete, the owner should institute a monitoring program to detect any significant changes in the condition of the dam and appurtenant structures. If significant changes occur, appropriate action should be taken as required.

All investigations, monitoring programs and design of remedial measures should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the owner should institute the following operational and maintenance procedures:

(1) Institute an inspection program such that the dam is visited frequently. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional

engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(2) Institute a maintenance program so that all features of the dam are properly maintained.

Submitted by:
GEO-TECHNICAL SERVICES, INC.

GIDEON YACHIN, P.E.

Date: May 13, 1981

Approved:
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 3 JUNE 1981

RESERVOIR AREA

DAM AREA

OVERVIEW OF FORDS POND (PA. 0298)

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FORDS LAKE DAM

NDI# PA-00298, PENNDER# 35-64

SECTION 1

GENERAL INFORMATION

1.1 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.2 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.3 Description of Project.

a. Dam and Appurtenances. Fords Lake Dam is a composite earthfill-masonry structure, terminating with earthfill embankments on both abutments. The 10.7 foot high dam has a total length of 215 feet, including the spillway and the earthfill embankment sections. The spillway, located at the middle of the dam, consists of a broad crested concrete weir with an effective length of 15 feet. The upstream approach to the spillway is riprapped. The outlet works consist of a 12-inch diameter cast iron pipe with upstream control.

b. Location. Fords Lake Dam is located on Buttermilk Creek in Newton Township, Lackawanna County, one-half mile north of Schultzville, Pennsylvania. The dam and reservoir are contained within the Ransom Pennsylvania 7.5 minute series USGS Quadrangle Map, at Latitude N41 29'23" and Longitude W75 45'58". A Location Map is shown in Exhibit E-1.

c. Size Classification. Small (10.7 feet high, 295 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (see paragraph 3.1e)

e. Ownership. Pennsylvania Fish Commission, Robinson Lane, Bellefonte, Pennsylvania 16823 (attention E. Jon Grindall, P.E.).

f. Purpose of Dam. Public Fishing.

g. Design and Construction History. Information related to the design and construction of the dam is not available. The present owner, Pennsylvania Fish Commission, acquired the facilities in 1968 from the Ford Estate. Data obtained from the Pennsylvania Department of Environmental Resources (PENNDER) indicates that the dam was in existence prior to the 1914 "Survey of Lakes" in Pennsylvania. Although "as-built" drawings are not available, inspection reports, correspondence and photographs document repairs and maintenance activities since 1957. This information is on file with the Pennsylvania Department of Environmental Resources (PENNDER) and the Pennsylvania Fish Commission.

h. Normal Operational Procedure. The pool is normally maintained at the spillway crest elevation with excess inflow discharging over the spillway into Buttermilk Creek.

1.4 Pertinent Data.

a. Drainage Area. (square miles)	1.07
b. Discharge at Damsite. (cfs)	
Maximum known flood at damsite since construction.	Not Known
Outlet works at maximum pool elevation (if made operative)	15± cfs estimated
Spillway capacity at maximum pool elevation	
Design Conditions	Not Known
Existing Conditions	43
c. Elevation. (feet above msl)	
Top of Dam	
Design Conditions	Not Known
Existing Conditions (low point)	1148.2
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	1148.2
Normal Pool (spillway crest)	1147
Upstream Invert Outlet Works	Not Known
Downstream Invert Outlet Works	1137.5
Streambed at Toe of Dam	1137.5
d. Reservoir Length. (feet)	
Normal Pool	4100
Maximum Pool (at top of dam)	4200

e. Storage. (acre-feet)

Normal Pool	212
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	295

f. Reservoir Surface. (acres)

Normal Pool	67
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	71

g. Dam.

Type (composite earthfill & Rubble Masonry)	
Length (feet) (Including spillway)	215
Height (feet)	10.7
Top Width (feet)	
Design Conditions	Not Known
Existing Conditions	varies from 6' to 15'
Side Slopes - Upstream	varies 1V:4.0H to 1V:2.5H
Downstream	near vertical wall
Zoning - See Type, above.	
Cut-off	Not Known
Impervious Core	Not Known
Grout Curtain	Not Known

h. Diversion and Regulating Tunnel. None

i. Spillway.

Type	Broad Crested Rectangular Weir
Length of Weir (feet)	11
Crest Elevation	1147.0
Upstream Channel	Riprap Bottom
Downstream Channel	Vertical drop to the natural streambed

j. Outlet Works.

Type	12" C.I.P. with upstream control valve
Length (feet) - estimated	+ 40
Closure and Regulating Facilities	Valve stem located on upstream slope
Access	From top of dam at normal pool

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. There is no available information related to the design and construction of the dam. The earliest information available consists of data compiled in connection with a Survey of Lakes, made at the direction of the Pennsylvania Water Supply Commission in 1914. An inspection report on the condition of the dam in August 1957 and correspondence related to a drawdown permit for fishery management in 1971 are on file with PENNDER. A 1974 inspection was conducted by the Fish Commission staff. The report on this inspection is on file with the Pennsylvania Fish Commission, Bellefonte, Pennsylvania.

b. Design Features.

1. Dam: The main dam is a masonry gravity structure with near-vertical downstream wall and an upstream earth embankment. The dry stone masonry wall is 10 feet high at its maximum section and 92 feet long, terminating with earthfill embankments on both abutments (see Photographs 4 and 5, Appendix C). The total length of the dam is 215 feet, including the earth embankments. The crest of the composite masonry-earthfill section of the dam varies in width from 6 feet near the earth embankment on the right abutment, to 15 feet near the earth embankment on the left abutment. The top of the embankment along its axis is about 1' higher than the top of the masonry structure on the downstream face of the dam, as indicated by the typical sections in Appendix A and shown in photographs 5 and 6, Appendix C. The upstream slope of the earth embankment within the composite section of the dam varies, with the steepest slope being 1 Vertical to 2.5 Horizontal (1V:2.5H). The maximum slopes of the abutment earth embankments are 1V:2.5H and 1V:2.4H for the upstream and downstream slope, respectively. The remnants of riprap on the upstream face of the dam suggest that protection of the upstream slope against erosive wave action was originally considered (see Photograph 1, Appendix C).

2. Appurtenant Structures:

(a) Spillway: The spillway is a rectangular shaped concrete structure, located at the center of the dam (see Exhibits A-1 and A-2, Appendix A and Photographs 6 and 8, Appendix C). The crest of the 11-foot long spillway is 1.9 feet below the top of the walls. The spillway walls, constructed of stone and concrete, are very badly damaged and parts of the walls are completely missing.

(b) Outlet Works: The outlet works consist of a 12-inch diameter cast iron pipe and a regulating mechanism, assumed to be a gate valve, located on the upstream end of the pipe. A section through the outlet works, showing the location of the regulating stem, is presented in Exhibit A-3, Appendix A. The pipe outlet is shown in Photographs 7 and 8, Appendix C.

2.2 Construction Records.

There are no records available for evaluation of construction methods and the classification or quality of materials placed in the dam.

2.3 Operation.

There are no records available to indicate the past operation procedures for the dam. The present normal operation of the facility is described in paragraph 1.2h, Section 1.

2.4 Other Investigations.

Available information indicates that on-site inspections were made in 1957 and 1974. The latter inspection was conducted on September 26, 1974 by the staff of the Pennsylvania Fish Commission for evaluation of a leakage problem. The inspection revealed seepage flow from the downstream face of the masonry structure and at several other areas. The flow of water could be heard by a person standing close to the downstream face of the dam. The total seepage flow was greater than 50 GPM.

2.5 Evaluation.

a. Availability of Data. Engineering data were extracted from the files of PENNDER and from information supplied by the Pennsylvania Fish Commission. The Owner's representatives stated that to the best of their knowledge, there are no plans or other information available on the design of the dam.

b. Adequacy. In the absence of plans, engineering specifications and construction records, assessment of the dam and its safety must be based primarily on the visual inspection and the hydrologic and hydraulic analysis presented in Section 5.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The overall appearance of the dam is very poor. Deficiencies observed during the field inspection are illustrated on the General Plan, Exhibit A-1, Appendix A. The profile and typical sections of the dam are presented in Exhibits A-2, A-3, and A-4, and are based on field survey made the day of the inspection. On the inspection date (12/08/80), the lake level was at elevation 1146.8, about 0.2 foot below spillway crest. Pertinent features observed are shown in photographs presented in Appendix C.

b. Dam. Observations made during the field inspection reveal that the earth and dry stone masonry dam is in very poor condition. The dam is reported to be 150 years old. Approximately 75 percent of the riprap on the upstream slope is missing and wave action has eroded some near vertical earth scarps (12 to 18 inches high) in the earth embankment. The in-place riprap is limited to 25 percent of the left upstream slope. The top width of the dam varies from 6 feet on parts of the right half to 15 feet on the left half of the dam. The top surface of the dam varies about 1 foot in elevation as illustrated on the dam profile, Exhibit A-2. An oval depresstion about 6 inches deep and 5 feet in diameter is located on the left half of the dam. This depression is reported to reoccur, deepen and be refilled annually. Immediately downstream of this depression is a point source leak with a clear flow of about 9 GPM exiting from the stone wall. Downstream of this leak is a large seepage area discharging an additional clear flow of 2 GPM (see Exhibit A-1). The Pennsylvania Fish Commission reports that on 9/26/74, they measured leakage of 50 GPM. These conditions and the 12 to 18 inch thick accumulation of silt and clay directly downstream suggests possible piping of embankment material. Between the depression and the spillway, two groundhog holes ranging from 3 to 4 inches in diameter extend into the embankment to depths exceeding 30 inches.

The downstream face of the dam is a vertical dry stone wall that extends about 10 feet above the streambed. The stones are "one and two man" sized sandstone slabs. The total length of standing wall is 92 feet. On the right abutment, the stone wall has bulges and overhangs of 12 to 18 inches. About 20 feet right of the wall end are sandstone slab remnants of a collapsed wall (see photographs No. 4 and No. 5, Appendix C). Scattered leakage through the stone wall extends from streambed to about 3.4 feet below the spillway crest for a distance of about 20 feet across the middle part of the dam (see photographs 2, 5 and 8, Appendix C). This leakage is clear and amounts to about 9 GPM. Downstream of the scattered wall leakage is a small marshy area at the toe of the right abutment (see Exhibit A-1).

c. Appurtenant Structures.

(1) Spillway: The appearance of the spillway is very poor. The spillway walls (24" high x 18" wide), constructed of stone and concrete, are so badly damaged that 75 percent of the right wall is missing and 25 percent of the left wall is missing (see photograph No. 6), resulting in a wider spillway channel (Paragraph 5.3b). The 6-inch thick stone and

concrete bottom slab is in fair condition. There was no flow over the spillway and the lake level was 0.2 foot below spillway crest on the inspection date. Local residents report that the June 1972 flood exceeded the spillway capacity and the flow overtopped the dam. No information relative to damage to the dam was available.

(2) Outlet Works: The outlet works consists of a 12-inch diameter cast iron pipe (see photographs No. 2 and No. 7) with an upstream gate valve located about 11 feet upstream of the dam centerline (see Exhibit A-3). The stem of the valve extending above the water surface is not operable. The Fish Commission reports unsuccessful efforts with large wrenches to operate the valve. There was no flow through the 12-inch drain. The entire flow of the stream is passing through the dam as leakage and seepage with a combined flow of about 20 GPM on the day of inspection.

d. Reservoir Area. The lower 50 percent of the watershed surrounding the lake is farmland with 5 to 20 percent slopes. The upper half of the watershed is wooded with 10 to 30 percent slopes. A 7-acre swamp is located about 1400 feet upstream of the lake. A public road parallels the west side of the lake and 11 homes and cottages are on the west side of this road. There is no evidence of unstable slope conditions which would affect the stability of the dam. Pertinent watershed features are presented in Exhibit E-1. Geologic conditions in the area are described in Appendix F.

e. Downstream Channel. About 100 feet downstream of the dam is the remnant of a breached stone and concrete dam. This breached dam still forms a small pond area. Downstream of the breached dam, the stream is in a narrow natural wooded ravine, about 30 feet deep with side slopes of about 1V on 2H. From 900 to 1200 feet downstream, these side slopes flatten and contain homes and lawn areas. The stream gradient in this 1200 foot stretch is about 3 percent. Downstream of this point, the stream gradient is about 2 percent and the valley floor widens.

Present stream encroachments within the first reach consist of a series of 5 small ponds with 4 to 5 feet high earth dams located 700 to 900 feet downstream of Fords Lake Dam. The first dwelling that would be affected by dam failure is located 900 feet downstream.

The downstream survey indicates that within the first mile downstream of the dam, 8 residences and two roads could be significantly damaged and more than a few lives may be lost should Fords Lake Dam fail. Consequently, Fords Lake Dam is classified as a high hazard structure.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedures.

The reservoir is maintained at normal pool with excess inflow discharging over the spillway. During low inflow periods, the entire flow leaks through the dam and pool levels drop below spillway crest elevation.

4.2 Maintenance of Dam.

Maintenance of the dam by the present owners is limited to annual refilling of the large depression and small groundhog holes on the left half of the dam crest. The absence of trash and debris indicates that cleanup activities are maintained. There was no evidence to indicate any recent repair of the spillway or downstream dry stone wall on the right abutment or to replace the missing riprap on the upstream slope.

4.3 Maintenance of Operating Facilities.

Efforts were made (9/24/74) by the present owners to turn the stem of the inoperable gate valve. After breaking two large pipe wrenches, no further efforts were made to repair or replace this valve.

4.4 Warning System in Effect.

The Fish Commission, in cooperation with the Pennsylvania Emergency Communications Council and Radio Emergency Action Communications, have a warning and evacuation plan in the event of potential failure.

4.5 Evaluation.

The maintenance of the dam, spillway and outlet works is unsatisfactory. The present owners make periodic inspections and are aware of the existing deficiencies.

SECTION 5
HYDROLOGY AND HYDRAULICS

5.1 Design Data.

There are no hydrologic and hydraulic data available for Fords Lake Dam.

5.2 Experience Data.

The probable flood of record in Buttermilk Creek is the March 1964 flood. Other major floods within the Susquehanna River Basin in this century are those of May 1942, August 1955, June 1972 and September 1975. Flood stages or flow records at the damsite or above the mouth of Buttermilk Creek are not available. No records are available on the maximum stage of the reservoir. A 1974 Inspection Report of the Pennsylvania Fish Commission indicates that the dam was overtopped during the 1972 flood and that all downstream residents were evacuated for fear of the dam collapsing.

5.3 Visual Observations.

Based on the visual inspection and field survey, described in Section 3 of this report, the observations relevant to hydrology and hydraulics are evaluated below.

a. Dam. The present low point on top of the dam is at elevation 1148.2. The present elevation of the spillway crest is 1147. Consequently, the maximum available freeboard for the dam is 1.2 feet. The variation in dam crest elevation shown in Exhibit A-2, Appendix A, is based on field survey conducted during the inspection. Consideration was given to the backwater effect from the downstream remnant dam on the tailwater elevation at the toe of Fords Lake Dam. Computed tailwater elevations for various discharges over the dam crest are presented in Appendix D.

b. Spillway. The broad crested weir has an effective length of 15 feet due to severe damage to the right wall. The present available head is 1.2 feet. The original rectangular spillway channel narrowed from 15 feet at the spillway crest to 11 feet at its termination with the downstream face of the dam. If the spillway walls and the top of the dam are restored to elevation 1148.9 (see Exhibits A-2 and A-4, Appendix A), the spillway capacity will be controlled by the 11-foot wide rectangular outlet. Consequently, the increase of the maximum head from 1.2 feet to 1.9 feet will increase the present spillway capacity from 43 cfs to 75 cfs, with due consideration given to the velocity head in the spillway. The present conditions of the spillway are illustrated in Exhibit A-1, Appendix A, and shown in Photographs 6 and 8, Appendix C.

c. Reservoir Area. There are no upstream structures of significant influence on the rate and time of flood inflow into Fords Lake. The relative location of Fords Lake with relation to the drainage area centroid is shown in Exhibit E-1, Appendix E. The longest distance from the Lake's intake to the drainage divide was employed for the determination of inflow hydrographs, presented in Appendix D. The present population density within the drainage area is very low. Should the future trend of development in the watershed remain similar to the development that took place since the construction of the dam, the extent of such development is not expected to alter significantly the present rate of

reservoir inflow during extreme floods.

d. Downstream Conditions. The location of the breached masonry dam, downstream of Fords Lake Dam, is shown in Exhibit A-1, Appendix A. The ponded area behind this downstream encroachment is shown in Photographs 10 and 11, Appendix C. On the day of the inspection (12/08/80), the spillway was not in operation. The total flow below Fords Lake Dam toe consisted entirely of seepage flow at the estimated rate of 20 Gallons per Minute. Computed tailwater elevations for spillway and dam overtopping discharges are presented in Appendix D. Due to the high hazard classification for the dam (see paragraph 3.1e), two stream stretches were selected for the determination of flood stage elevations resulting from the dam break analysis. The location of the selected stretches are shown on Exhibit E-1, Appendix E. Typical channel sections, representing the end of each stream reach, are presented in Appendix D. Each section was selected with due consideration given to the backwater effect from bridges or other stream encroachments. Hazard to life and property damage, resulting from a dam failure, is limited to the first 4900 feet of Buttermilk Creek below the dam.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore district, Phase - I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis is presented in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of the Fords Lake Dam is between the one-half Probable Maximum Flood (1/2 PMF) and the full PMF. Based on the potential hazard survey, downstream of the dam, the 1/2 PMF is selected as the SDF for the Fords Lake Dam. The computed 1/2 PMF is approximately 1550 cfs.

b. Results of Analysis. The watershed modeling using the HEC-1DB computer program indicates that the spillway can only pass 1% of the PMF without overtopping.

The SDF of 1/2 PMF would overtop the dam to a depth of 2.3 feet for a period of 10 hours. Flood flows of 0.2 PMF would overtop the dam to a depth of 1.2 feet for a period of 8.25 hours. It is assumed that if the Dam is substantially overtopped, erosion and failure will occur. Dam breach analyses were performed assuming the Dam would fail at overtopping depths slightly greater than 1.0' and the breach width would be 15' to 30'. The bottom of the breach was assumed to be the natural streambed, elevation 1137.6. Flows corresponding to 0.2 PMF, the assumed minimum flow which would cause failure, and 0.5 PMF, the SDF, were used for the analyses.

The results indicate that the maximum outflow at failure for the 0.2 PMF would be approximately 2890 cfs. When this flow is routed downstream to the first group of dwellings, the flood stage is increased by approximately 3.0 feet over the water surface that would have occurred had the dam not failed. For the lower reach studied, an increased flood stage of 6.6 feet was calculated. The sudden increase in the flood stages at those reaches over the water surface that existed just prior to overtopping is estimated to be 2 to 3 times these values. This increase in flood stage constitutes a serious hazard to property with the possibility of loss of several lives. A summary of computer analyses is tabulated at the end of Appendix D.

c. Spillway Adequacy. Because the occurrence of 1/2 PMF may cause failure of the dam due to overtopping and because the hazard to life and property downstream would be increased, the spillway is considered to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection of Fords Lake Dam is described in Section 3. Observations that are relevant to structural stability of the dam and the appurtenant structures are evaluated below.

a. Dam. A shallow 5-foot diameter depression on top of the dam is located opposite a point source seepage at the toe of the rubble masonry wall (see Exhibit A-1 and Photograph 7, Appendix C). Although the measured flow on the inspection date was clear, the existence of internal erosion in the upstream earth material by seepage forces could not be ruled out by the observed conditions. Annual backfilling of the depression by the Fish Commission personnel and the observed accumulation of silt and clay directly downstream of the seepage area suggest that internal erosion in the upstream earthfill section of the dam has been in progress for quite some time. If this piping and internal erosion of the embankment remains unchecked, the expected undermining of the rubble masonry section could affect the structural integrity of the dam. A relatively high elevation of seeps, depicted by icicle formation on the downstream face of the dam, was noted. The relatively high elevation of the seepage exit line suggests possible clogging of the voids within the stone by the migration of soil particles from the upstream earthfill section of the dam. The collapsed section of the right wall and the displacement and bulges in the masonry wall suggest instability of the structure.

Although the observed conditions are insufficient for quantitative analysis of the dam stability, they indicate that additional investigations are urgently required to determine the remedial measures necessary to insure the integrity of the structure.

b. Appurtenant Structures.

(1) Spillway: The broken spillway walls provide direct contact between the flowing water and the adjacent earth embankment. Flow velocities associated with high spillway discharges can be sufficient to erode the unprotected embankment soils. These velocities could also undermine the spillway slab, causing cracks or complete failure by uplift and washout. Failure of the slab would allow erosion of the underlying earth material and affect the stability of the dam.

(2) Outlet Works: The Pennsylvania Survey of Lakes, conducted in 1914, does not indicate the existence of outlet works in the Fords Lake Dam. The first indication of an existing outlet is in the 1957 dam inspection report, cited in paragraphs 2.1a and 2.4, Section 2. The actual age and condition of the 12-inch diameter cast iron pipe and the operating facilities are not known. The operating mechanism, reported to be a gate valve located on the upstream portion of the pipe, is not operable. Consequently, the structural integrity of the pipe under pressure flow conditions could not be verified.

6.2 Design and Construction Data.

Available design and construction data are inadequate to assess the structural integrity of the dam.

6.3 Past Performance.

The available data strongly indicate that the structure is rapidly deteriorating and in urgent need of repair.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1. Generally, if static stability is assured, then seismic stability will be satisfactory. However, there has been no static stability analysis made for the dam and therefore, the seismic stability of the dam cannot be assessed.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on available records, past performance, visual inspection, field survey and calculations, the Fords Lake Dam is judged to be in poor condition. The dam is classified as high hazard with a seriously inadequate spillway and has serious structural deficiencies as previously cited. On this basis, the dam is considered unsafe, non-emergency.

Based on the size and hazard classification of the dam, the recommended Spillway Design Flood (SDF) is the 1/2 PMF. The present spillway can pass approximately 1% of the PMF before overtopping of the dam occurs. It is judged that the dam could not withstand overtopping by flows greater than 0.2 PMF without failing. Failure of the dam would create an increased hazard to loss of life. Therefore, the spillway is seriously inadequate.

(2) Visual evidence suggests that internal erosion in the dam has occurred and may continue to occur. This internal erosion can seriously affect the structural stability of the dam.

(3) The deteriorated spillway walls expose the adjacent earthfill embankment to erosion during periods of spillway discharge. Excessive erosion of the earth embankment is detrimental to the safety of the dam.

(4) There is no operable outlet works for the dam.

(5) The present maintenance of the dam is unsatisfactory.

b. Adequacy of Information. The data collected from previously cited dam inspection reports, past performance, visual inspection and computations performed as part of this study are sufficient for the Phase I Dam safety assessment.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by a professional engineer, experienced in the design and construction of dams, will be necessary.

7.2 Recommendations and Remedial Measures.

a. The following investigations and remedial measures are recommended for immediate implementation by the owner.

(1) Perform additional studies to ascertain more accurately the required spillway capacity and implement the necessary corrective actions.

(2) Perform investigations to determine the subsurface foundation and embankment conditions relative to the indicated internal erosion problems and the sturctural stability of the dam. These investigations should include monitoring of the seepage quantity and turbidity. Design and construct remedial measures as necessary.

(3) Perform temporary repairs to the existing spillway walls to prevent embankment erosion until an adequate spillway is constructed.

(4) Provide a method of drawing down the lake.

(5) Provide additional erosion protection along the upstream crest of the dam to prevent wave erosion.

(6) Fill the subsidence depression and groundhog holes on the dam crest.

(7) Until the investigations recommended above are complete, the owner should institute a monitoring program to detect any significant changes in the condition of the dam and appurtenant structures. If significant changes occur, appropriate action should be taken as required.

All investigations, monitoring programs, and design of remedial measures should be performed by a professional engineer experienced in the design and construction of dams.

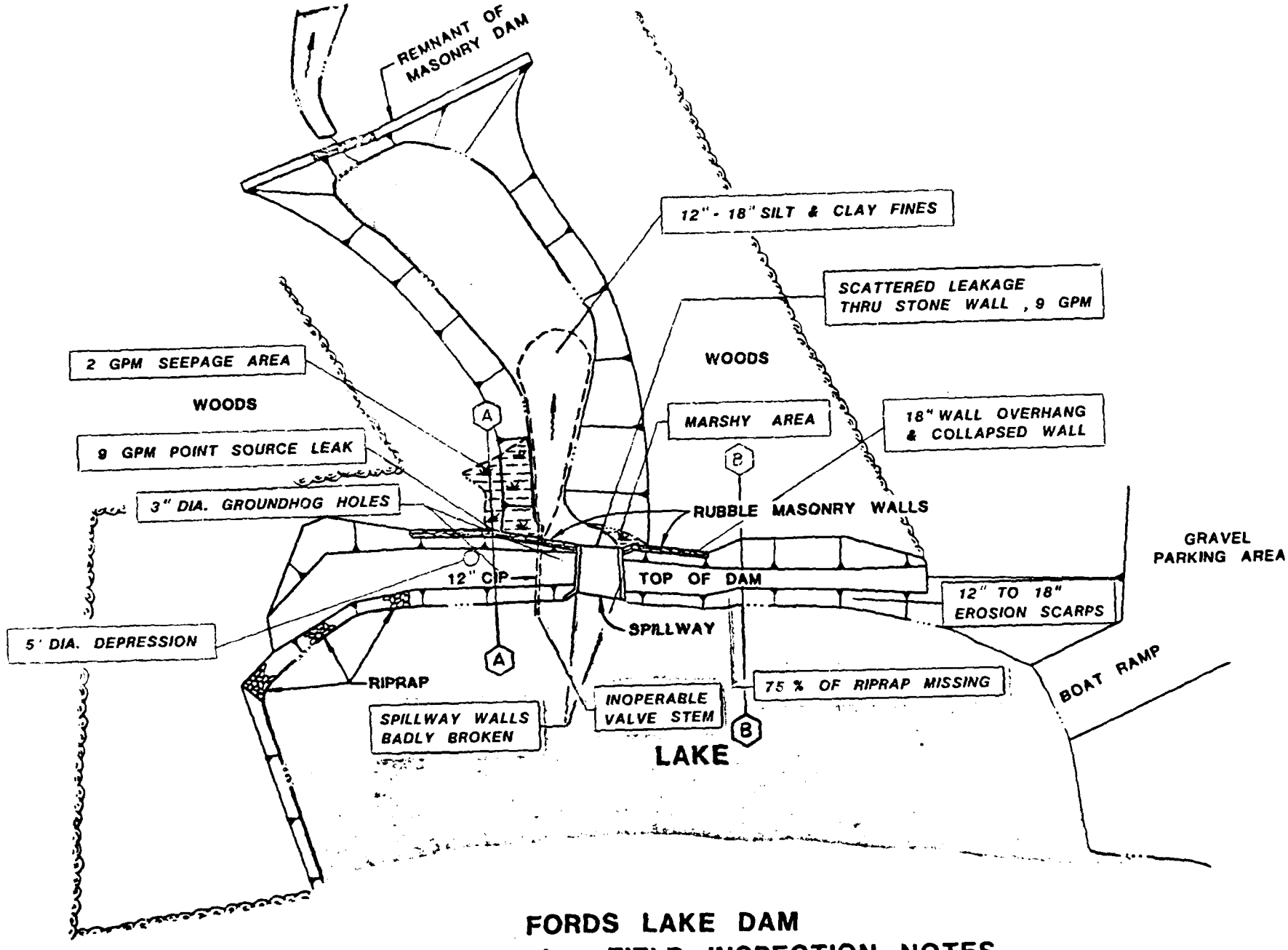
b. In addition, the owner should institute the following operational and maintenance procedures:

(1) Institute an inspection program such that the dam is visited frequently. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(2) Institute a maintenance program so that all features of the dam are properly maintained.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES



FORDS LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES

EXHIBIT A-1

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB FORDS LAKE DER 35-64

SHEET NO _____ OF _____

CALCULATED BY RJM DATE 1-27-81

CHECKED BY _____ DATE _____

SCALE HORZ. 1" = 50' VERT. 1" = 4'

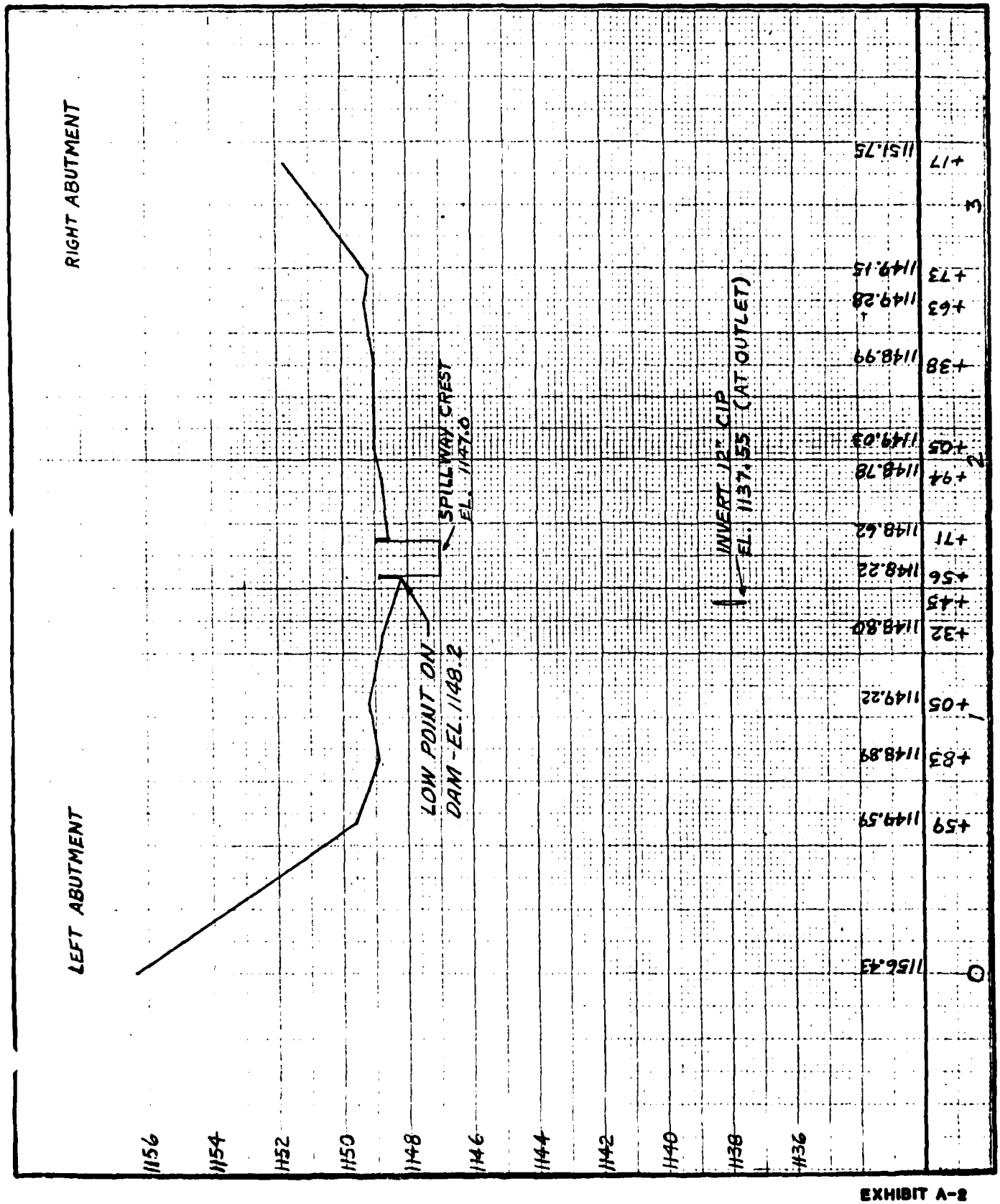
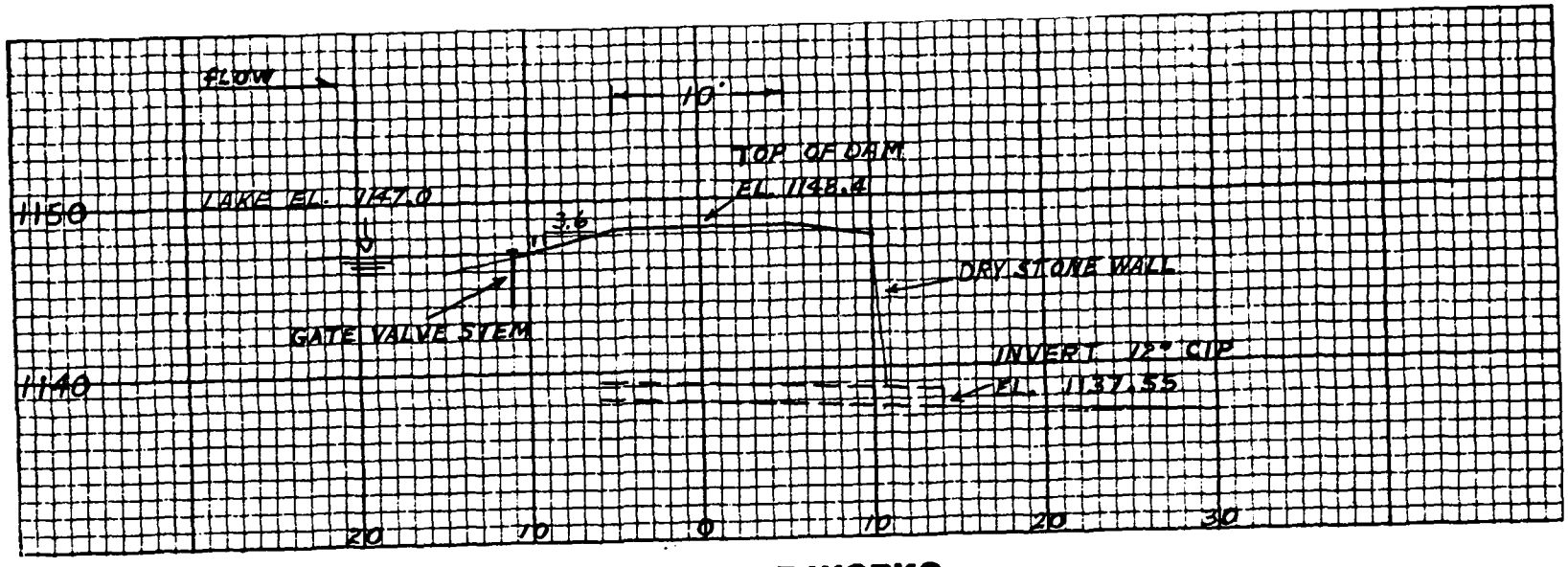
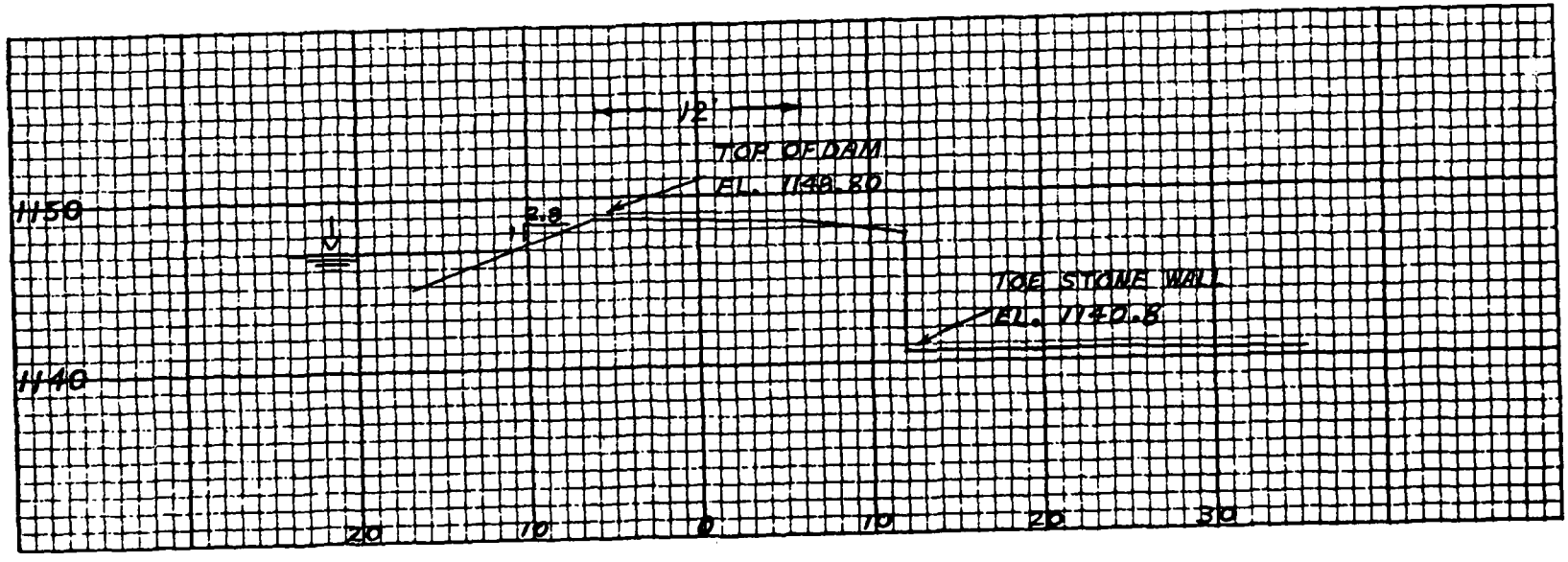


EXHIBIT A-2

TYPICAL DAM SECTIONS



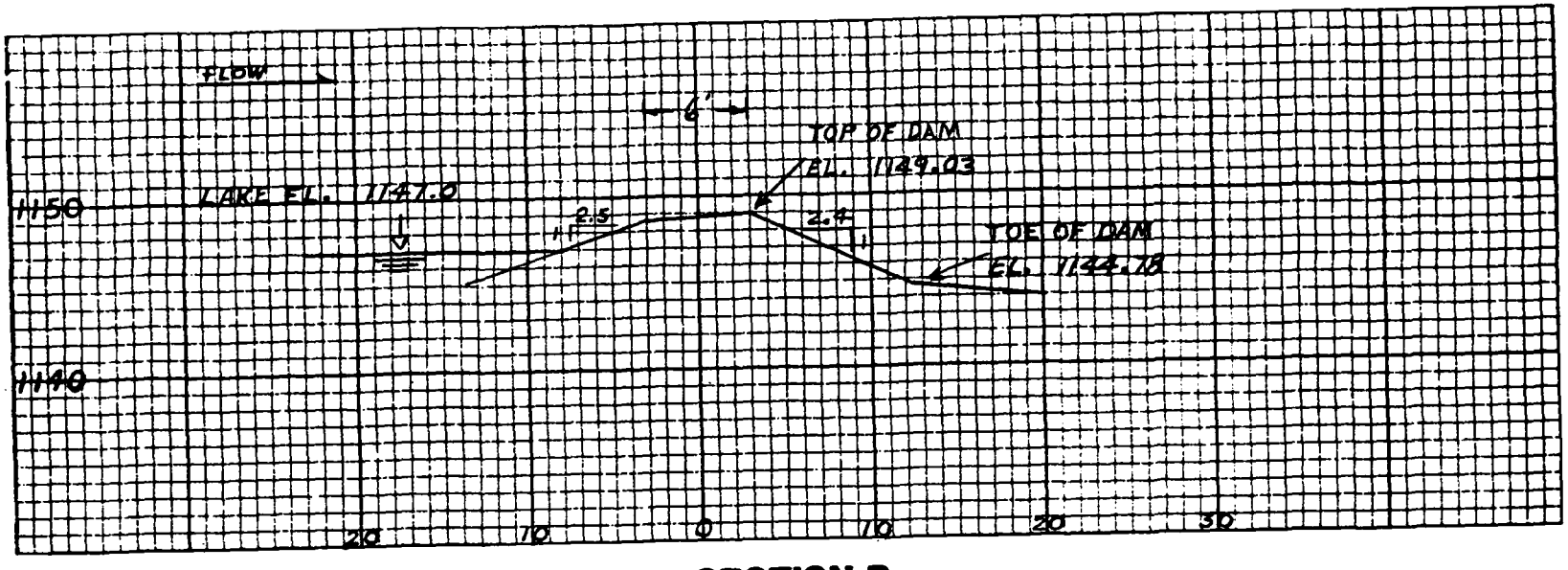
OUTLET WORKS



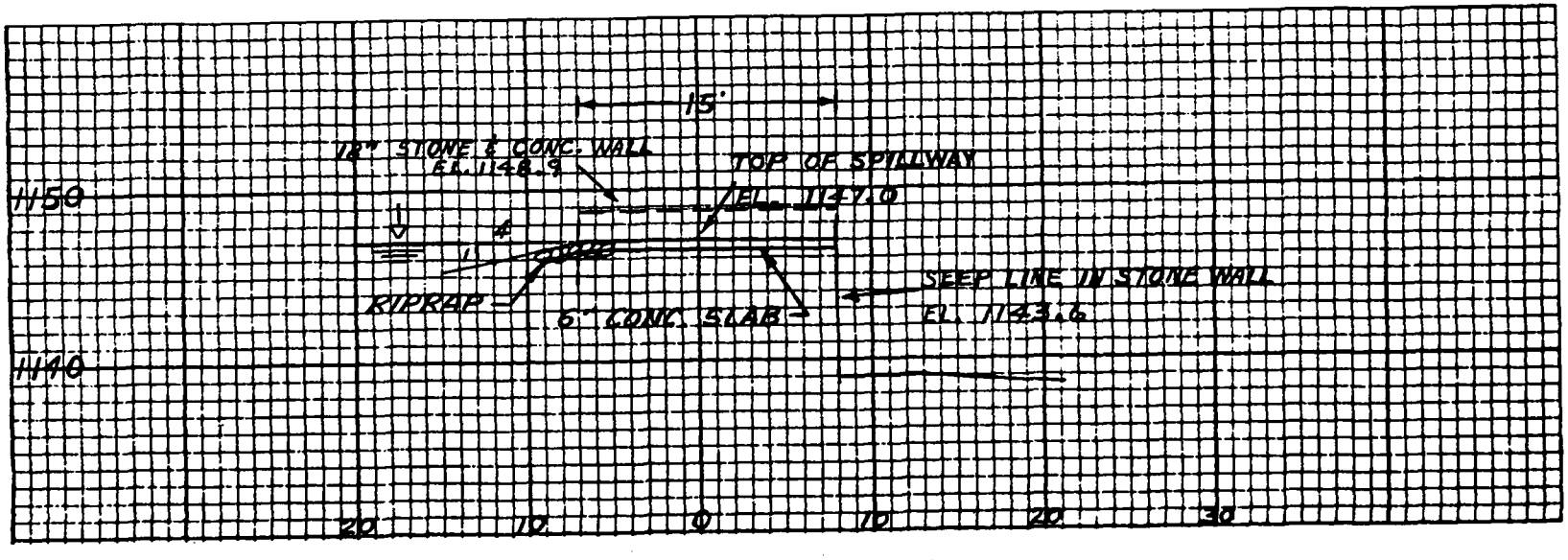
SECTION A

EXHIBIT A-8

TYPICAL DAM SECTIONS



SECTION B



SPILLWAY SECTION

EXHIBIT A-4

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Ford's Lake Dam STATE Pennsylvania COUNTY Lackawanna

NDI # PA — 298 PENNDER # 35-064

TYPE OF DAM Dry Stone Masonry & Earth Fill SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 12/08/80 WEATHER Cloudy TEMPERATURE 45°F @ 11:00 A.M.

POOL ELEVATION AT TIME OF INSPECTION 1147.0 M.S.L.

TAILWATER AT TIME OF INSPECTION 1136.6 M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
Gideon Yachin - Engineer	Charles Ryport, Pa. Fish Commission	
James Diaz - Geologist	E. Jon Grindall, Pa. Fish Comm.	
Ronald Mather - Surveyor	Daniel O'Neill, Pa. Fish Comm.	

RECORDED BY James Diaz

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 298
SURFACE CRACKS	On left half of dam, a 5' diameter, 6" deep depression (refilled annually) and two 3" and 4" dia groundhog holes are present.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	The 12"to 18" of silt and clay fines in the downstream pond area and annual refilling of the 5' diameter depression suggests washing out of embankment material.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Downstream vertical face of dry stone wall has 12"to 18" overhang bulges and 20'$\pm$ of right end has fallen.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Downstream vertical wall has downstream bulges and overhang up to 18". For horizontal and vertical crest alignment, see Exhibits A-1 and A-2 respectively.
RIPRAP FAILURES	75% of upstream riprap above waterline is pushed into water and earth embankment is exposed above waterline. Occasional vertical earth scarps 12"-18" indicate wave erosion.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Seepage areas on lower parts of both downstream abutments and wall failure on right abutment.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 298
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	Wet, green, marshy areas on lower parts of both abutments.
ANY NOTICEABLE SEEPAGE	Seepage is pronounced at the downstream toe of both abutments.
STAFF GAGE AND RECORDER	None
DRAINS	None visible.
ROCK OUTCROPS	None
MISCELLANEOUS	

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 298
INTAKE STRUCTURE	None visible.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	12" diameter C.I.P. with gate valve control on upstream slope. Gate valve not operable.
OUTLET STRUCTURE	None. Outlet pipe terminates approximately 3 feet downstream of the masonry face of the dam.
OUTLET CHANNEL	Outlet pipe drains into ponded area (3/4 acre $\pm$) of breached stone & concrete dam (see Exhibit A-1, Appendix A and photographs 10, 11, Appendix C).
GATE(S) AND OPERATIONAL EQUIPMENT	12" Gate valve (indicated by pipe diameter). Valve is not operable.
CONCRETE SURFACES CRACKS, SPALLING JOINTS	NA

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 298
TYPE AND CONDITION	Concrete slab with stone and concrete walls (24"h x 18"w). Slab in fair condition. Walls in very poor condition with 75% of right wall missing and 25% of left wall missing. (see photo No. 6, Appendix C).
APPROACH CHANNEL	Spillway approach narrows from 15.0 to 11.0'. Bottom is lined with stone riprap.
SPILLWAY CHANNEL AND SIDEWALLS	6" $\pm$ stone & concrete slab in fair condition. 24" high x 18" wide stone & concrete walls in very poor condition. Most of right wall missing.
STILLING BASIN PLUNGE POOL	No constructed stilling basin. However, the pond from breached downstream dam serves as a plunge pool. during significant spillway discharges.
DISCHARGE CHANNEL	Ponded area created by a downstream breached dam. (see Photo No.10, Appendix C).
BRIDGE AND PIERS EMERGENCY GATES	None

SERVICE SPILLWAY (NONE)

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 298
TYPE AND CONDITION	N.A.
APPROACH CHANNEL	N.A.
OUTLET STRUCTURE	N.A.
DISCHARGE CHANNEL	N.A.

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA. 298
MONUMENTATION SURVEYS	None
OBSERVATION WELLS	None
WEIRS	None
PIEZOMETERS	None
OTHERS	
OPERATION & MAINTENANCE DATA	Annual filling of depression on left embankment. No repair work on concrete walls, stone walls or riprap.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 298
SLOPES: RESERVOIR	Gentle to moderate (15% $\pm$) partly wooded slopes.
SEDIMENTATION	Several acres of silt, clay and fine sand are deposited at the upper end of the lake.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Breached dry stone and concrete dam with concrete face 150' $\pm$ downstream. Natural wooded stream channel further donwstream.
SLOPES: CHANNEL VALLEY	The first 900 feet downstream is a steep, narrow, natural wooded valley about 30 feet deep with 1 on 2 side slopes. Further downstream, the valley floor widens, slopes are flatter, and contains homes and open areas.
APPROXIMATE NUMBER OF HOMES AND POPULATION	In a distance of about one mile downstream, there are 8 occupied dwellings, located less than 100 feet from and 2.5 to 7.5 feet above the stream channel.
WATERSHED DESCRIPTION	Wooded with some farmland in the areas adjacent to the lake.

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM FORD'S LAKE DAM

NDI# PA - 00298

ITEM	REMARKS
PERSONS INTERVIEWED AND TITLE	E. Jon Grindall, P.E., Senior Project Engineer, Bureau of Fisheries and Engineering, Pennsylvania Fish Commission.
REGIONAL VICINITY MAP	See Exhibit E-1, Appendix E.
CONSTRUCTION HISTORY	Constructed prior to the "Survey of Lakes", made at the direction of the Pennsylvania Water Supply Commission, in 1914.
AVAILABLE DRAWINGS	None
TYPICAL DAM SECTIONS	See Exhibits A-3 and A-4, Appendix A (based on survey mode on 12/08/80).
OUTLETS. PLAN DETAILS DISCHARGE RATINGS	Construction plans not available. For present conditions, see Exhibits A-1 and A-3, Appendix A. Not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS
SPILLWAY: PLAN SECTION DETAILS	Construction Drawings are not available. For present conditions, see Exhibit A-1 Exhibit A-4
OPERATING EQUIP- MENT PLANS AND DETAILS	Upstream control for the 12-inch diameter CIP conduit is inoperable. For location of the valve stem, see Exhibits A-1 and A-3, Appendix A.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 298
BORROW SOURCES	Not known	
POST CONSTRUCTION DAM SURVEYS	None available prior to 1980. For conditions on 12/08/80, see top of dam profile and typical sections, Appendix A.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection reports: 1914 & 1957 - PennDER file. 1974 - Fish Commission file. Inundation Map: 1979 - Pa. Fish Commission file.	
HIGH POOL RECORDS	None. Local sources reported that overtopping occurred during June 1972 Flood.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	Not known.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 298
PRIOR ACCIDENTS OR FAILURES	Not reported.
MAINTENANCE RECORDS MANUAL	Not available. Attempt was made to operate the outlet works on 9/28/74 to no avail. Annual filling of depression on left abutment has been reported.
OPERATION: RECORDS MANUAL	Not available.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	The owners,in cooperation with the Pennsylvania Emergency Communications Council and REAC, have a warning and evacuation plan in the event of potential failure. There is no unattended warning system at the dam at the present time.
MISCELLANEOUS	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # 00298
PENNDER ID # 35-064

SIZE OF DRAINAGE AREA: 1.07 square miles

ELEVATION TOP NORMAL POOL: 1147 STORAGE CAPACITY 212 acre-feet

ELEVATION TOP FLOOD CONTROL POOL NA STORAGE CAPACITY NA

ELEVATION MAXIMUM DESIGN POOL 1148.2 STORAGE CAPACITY 295 acre-feet

ELEVATION TOP DAM: 1148.2 STORAGE CAPACITY: 295 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1147.0 feet above mean sea level

TYPE: Uncontrolled Broad Crested Rectangular Weir

CREST LENGTH: 11 feet

CHANNEL LENGTH: 15 feet

SPILLOVER LOCATION: At center of dam

NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 12" diameter C.I.P.

LOCATION: At the maximum dam section, left of spillway

ENTRANCE INVERTS: Not known

EXIT INVERTS: 1137.5 feet

EMERGENCY DRAWDOWN FACILITIES: Inoperable upstream control.

HYDROMETEOROLOGICAL GAGES

TYPE: None

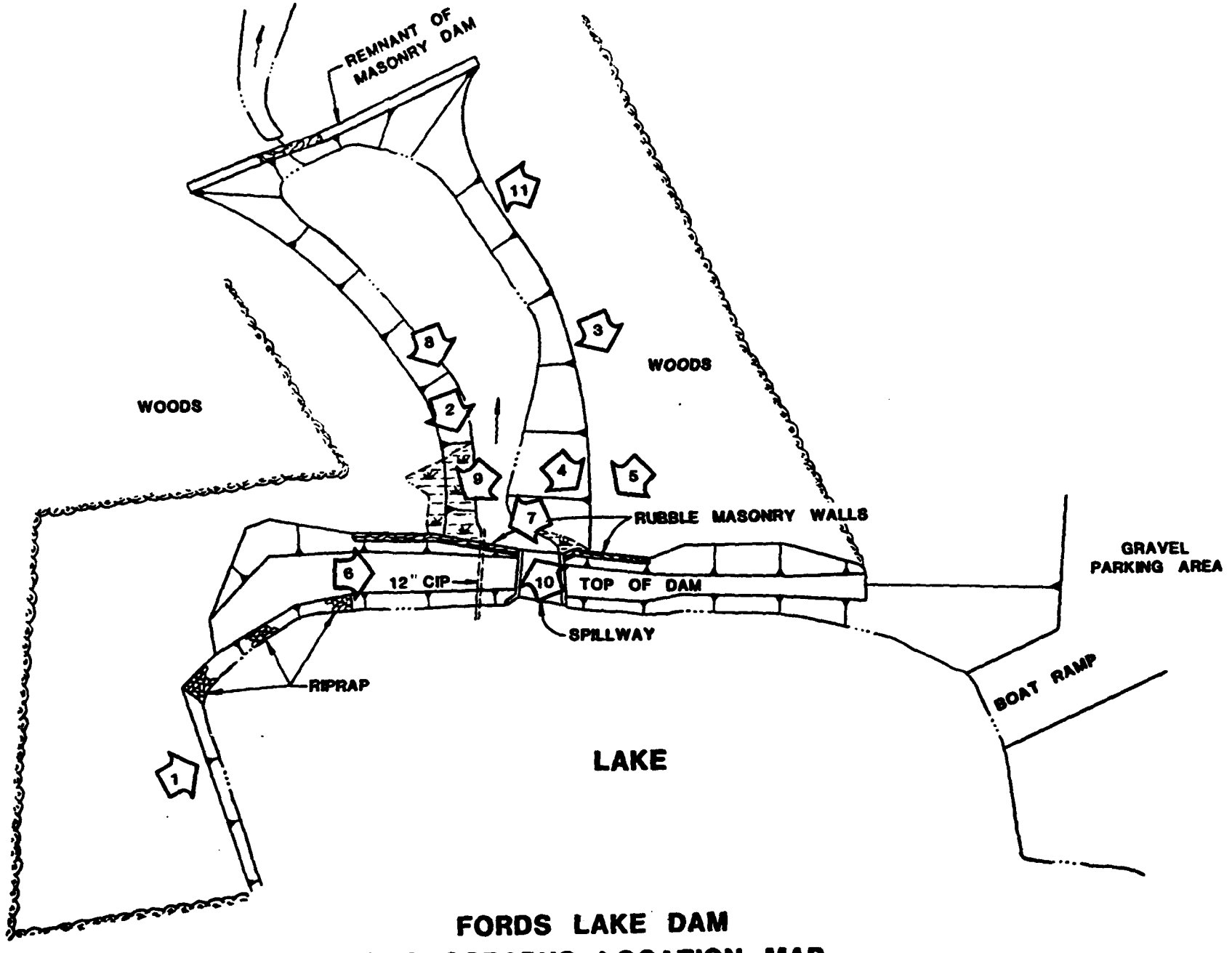
LOCATION: None

RECORDS: None

MAXIMUM NON-DAMAGING DISCHARGE: 43 cfs

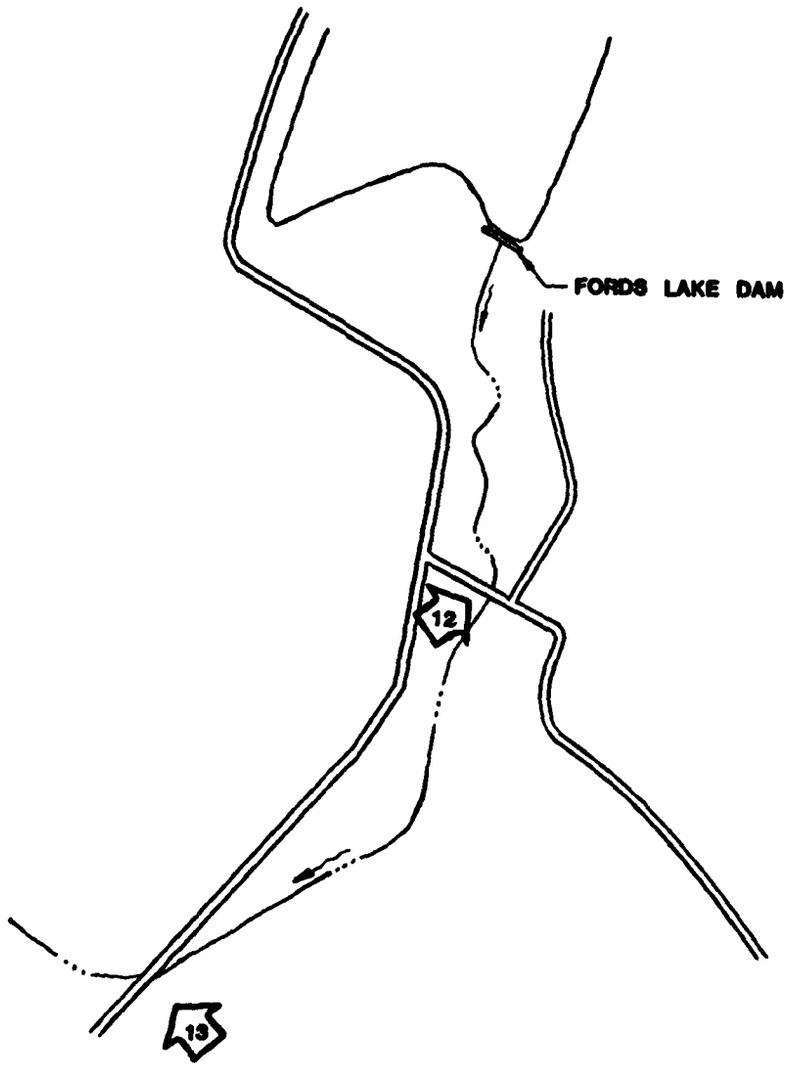
APPENDIX C

PHOTOGRAPHS



FORDS LAKE DAM
PHOTOGRAPHS LOCATION MAP

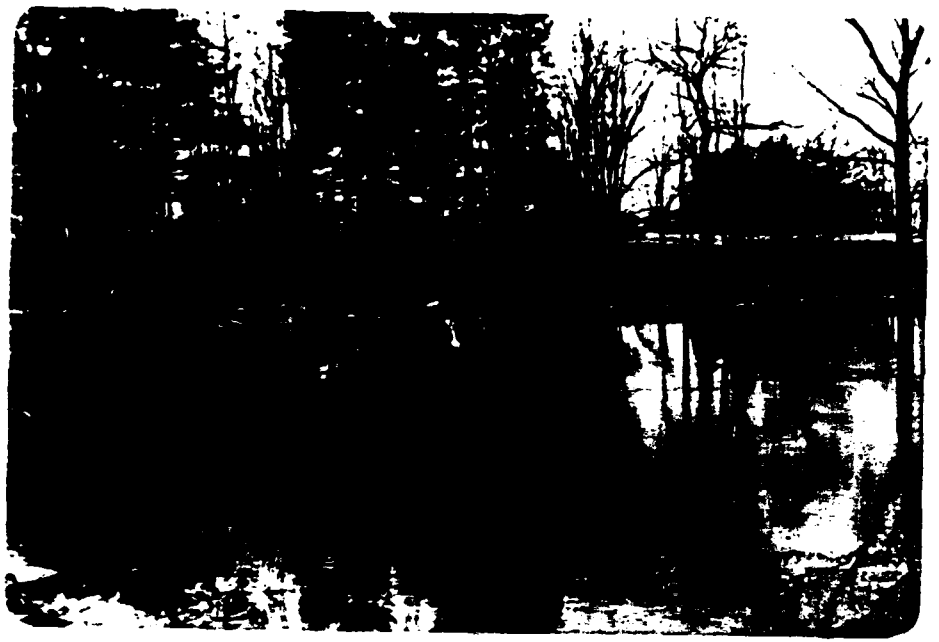
SHEET O-1



FORDS LAKE DAM

DOWNSTREAM PHOTOGRAPHS LOCATION MAP

EXHIBIT C-2

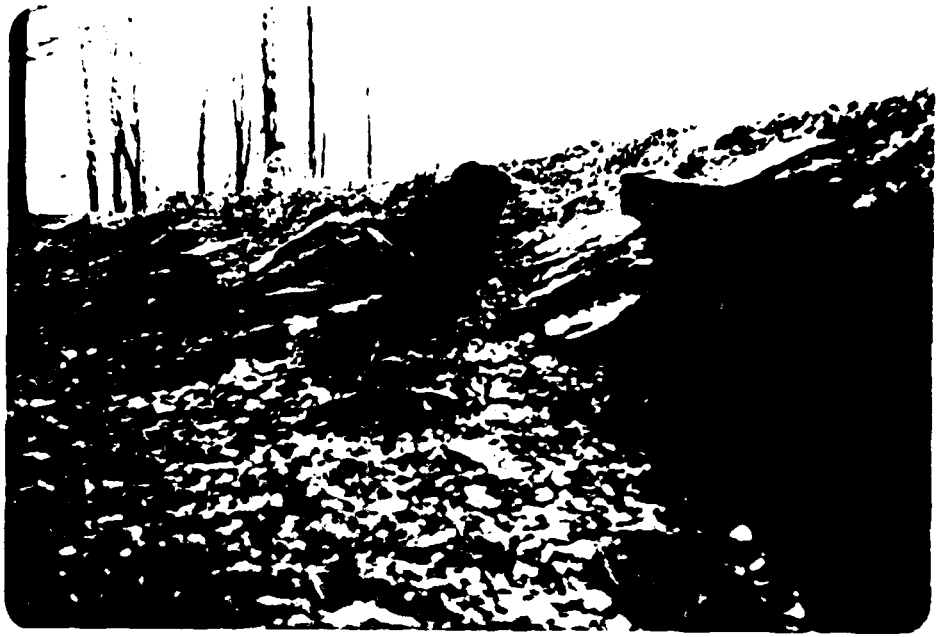


1. UPSTREAM VIEW (FROM LEFT BANK)

2. DOWNSTREAM MASONRY FACE

(OUTLET PIPE IN FOREGROUND)

3 LOOKING UPSTREAM ON RIGHT ABUTMENT



4. FAILURE OF DOWNSTREAM MASONRY DRY WALL
(LOOKING UPSTREAM TOWARD RIGHT ABUTMENT)

5. DOWNSTREAM FACE OF DRY MASONRY WALL
(NOTE : UPPER LIMIT OF SEEPAGE , DEPICTED BY ICICLES)

6. TOP OF DAM : LOOKING TOWARD RIGHT ABUTMENT

7. OUTLET PIPE (12" DIA. CIP.)

9 GPM LEAK AT ARROW

8. DOWNSTREAM MASONRY WALL (SPILLWAY, TOP LEFT:

OUTLET PIPE , LEFT OF RANGE POLE)

9. INSERT : SHOWING SEEPAGE AT TOE

10. DOWNSTREAM CHANNEL (SPILLWAY IN FOREGROUND)

11. DOWNSTREAM PONDING AREA AND REMNANT OF DAM

12. DOWNSTREAM OF HOME , 900' BELOW DAM

13. UPSTREAM OF HOME, 1/2 MILE BELOW DAM

APPENDIX D

HYDROLOGY AND HYDRAULICS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

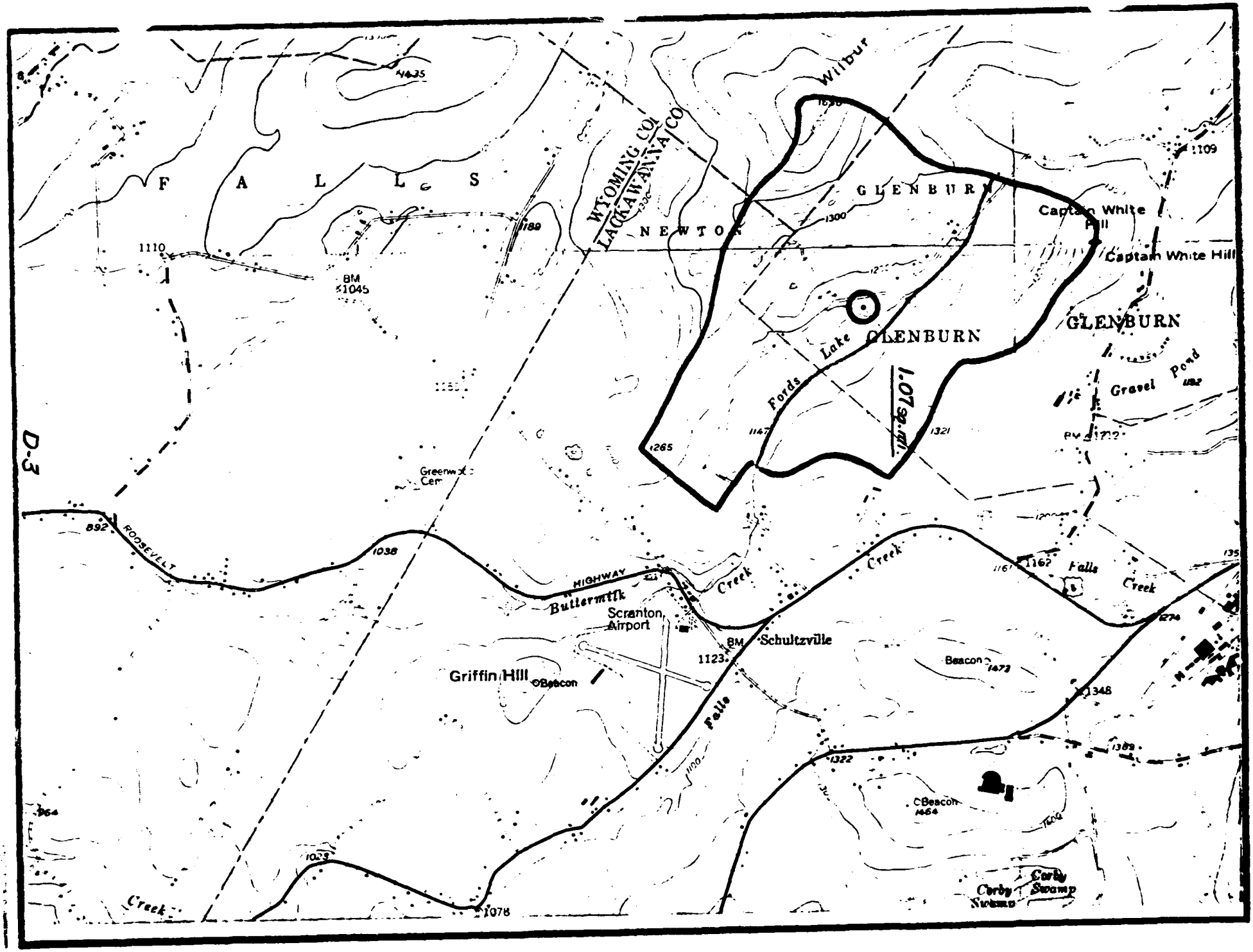
JOB FOLD'S LAKE DAM PA 298
SHEET NO _____ OF _____
CALCULATED BY WEH DATE _____
CHECKED BY _____ DATE _____
SCALE _____

SUMMARY OF HYDRAULIC CALCULATIONS

1.) MULTI-RATIO OVERTOPPING ANALYSIS

2.) ROUTE TO DOWNSTREAM SECTIONS

3.) PERFORM BREACH ANALYSIS


F A L L S
WYOMING CO
LACKAWANNA CO
NEWTON
GLENBURN
Wilbur
Captain White Hill
Captain White Hill
GLENBURN
Lake GLENBURN
Fords
1.07 sq. mi.
Gravel Pond
BM 1045
1110
1435
1189
1300
1109
1265
1147
1321
D-3
Greenwood Cem
892
ROOSEVELT HIGHWAY
1038
Buttermilk Creek
Scranton Airport
BM 1123
Schultzville
Griffin Hill
Beacon
Falls Creek
Falls Creek
1162
Falls Creek
1348
1322
1389
Beacon 1464
1078
Corby Swamp
Corby Swamp

GENERAL DATA

RIVER BASIN	SUSQUEHANNA (SUB-BASIN 4)*
STREAM NAME	BUTTERMILK CREEK
DAM NAME	FORD'S LAKE DAM
NDI ID No.	PA 00298
DER ID No.	35-064
OWNER	PA. FISH COMMISSION
LOCATION	NEWTON TWP., LACKAWANNA Co., PA
	LAT. N 41° 29' 23"
	LONG. W 75° 45' 58"
SIZE CATEGORY	SMALL
HAZARD CATEGORY	HIGH
UPSTR. DAMS	NONE
DOWNSTR. DAMS	NONE

* PENN-DER WATER RESOURCES BULLETIN No. 5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

DRAINAGE BASIN & UNIT HYDROGRAPH DATA

DRAINAGE AREA 1.07 Sq. Mi.

SNYDER UNIT HYDROGRAPH COEFFICIENTS
AS SUPPLIED BY BALT. DIST. COE (SUSQUEHANNA BASIN ZONE 11)

$C_p = 0.62$
$C_t = 1.50$

LAG TIME - DUE TO LOCATION OF CENTROID
USE $T_p = C_t \times L'^{0.6}$
$L' = 0.47$ Mi. FROM RESERVOIR INLET
TO DRAINAGE DIVIDE
$\therefore T_p = 1.50 \times 0.47^{0.6} = 0.95$ HRS.

RAINFALL DATA

PER HYDROMETEOROLOGICAL REPORT No. 40 (SUSQUEHANNA BASIN)
GEOGRAPHIC ADJUSTMENT FACTOR = 0.96
PMF RAINFALL = 22.2" (24 HR. & 200 SQ. MI.)
= 22.2 x 0.96 = 21.3"

RAINFALL DISTRIBUTION

6 HR	118 %
12 HR	127 %
24 HR	136 %
48 HR	142 %

DAM DATA

TOP OF DAM ELEV. (LOW POINT)	1148.2
DAM LENGTH (INC. SPILLWAY)	215' ±
DAM HEIGHT	10.7'
DAM WIDTH	6' to 12'
"C" VALUE - DAM	2.7

NON-LEVEL DAM

LENGTH OF DAM	BELOW ELEV.
0'	1148.2
87'	1149.0
178'	1149.2
223'	1149.6
280'	1151.7

SPILLWAY DATA

SPILLWAY TYPE	BROAD-CRESTED WEIR (CONC.)
CREST ELEV.	1147.0
SPILLWAY LENGTH	11.0' @ DNSTR. END
WIDTH	15.0' (AVG.)
SPILLWAY HEAD AVAILABLE	1.2'
"C" VALUE - SPILLWAY (≥ 2.7)	USE 3.0
MAX. SPILLWAY DISCHARGE	$Q = CLH^{3/2} = (3)(11)(1.2)^{3/2} = 43$ CFS

OUTLET WORKS DATA

OUTLET TYPE

NORMAL POOL LEVEL IS MAINTAINED AT THE SPILLWAY CREST ELEV. 1147.0
THE LAKE DRAIN IS A 12" C.I.P. W/ UPSTR. GATE & IS NORMALLY CLOSED & PRESENTLY INOPERATIVE.

STORAGE DATA

ELEV. (FT.)	AREA (AC.)	STORAGE (MG.)	STORAGE (AC.FT.)	DESCRIPTION.
1137.5 (1)	0	0	0	RESERVOIR BOT.
1147.0	67	68 *	212	SPILLWAY CREST
1148.2	71	96	295	TOP OF DAM
1160.0	111			CONTOUR

(1) ESTABLISH ELEV. @ 0 AREA

USE STORAGE PER BULLETIN 5 OF 68 MG. @ ELEV. 1147.0

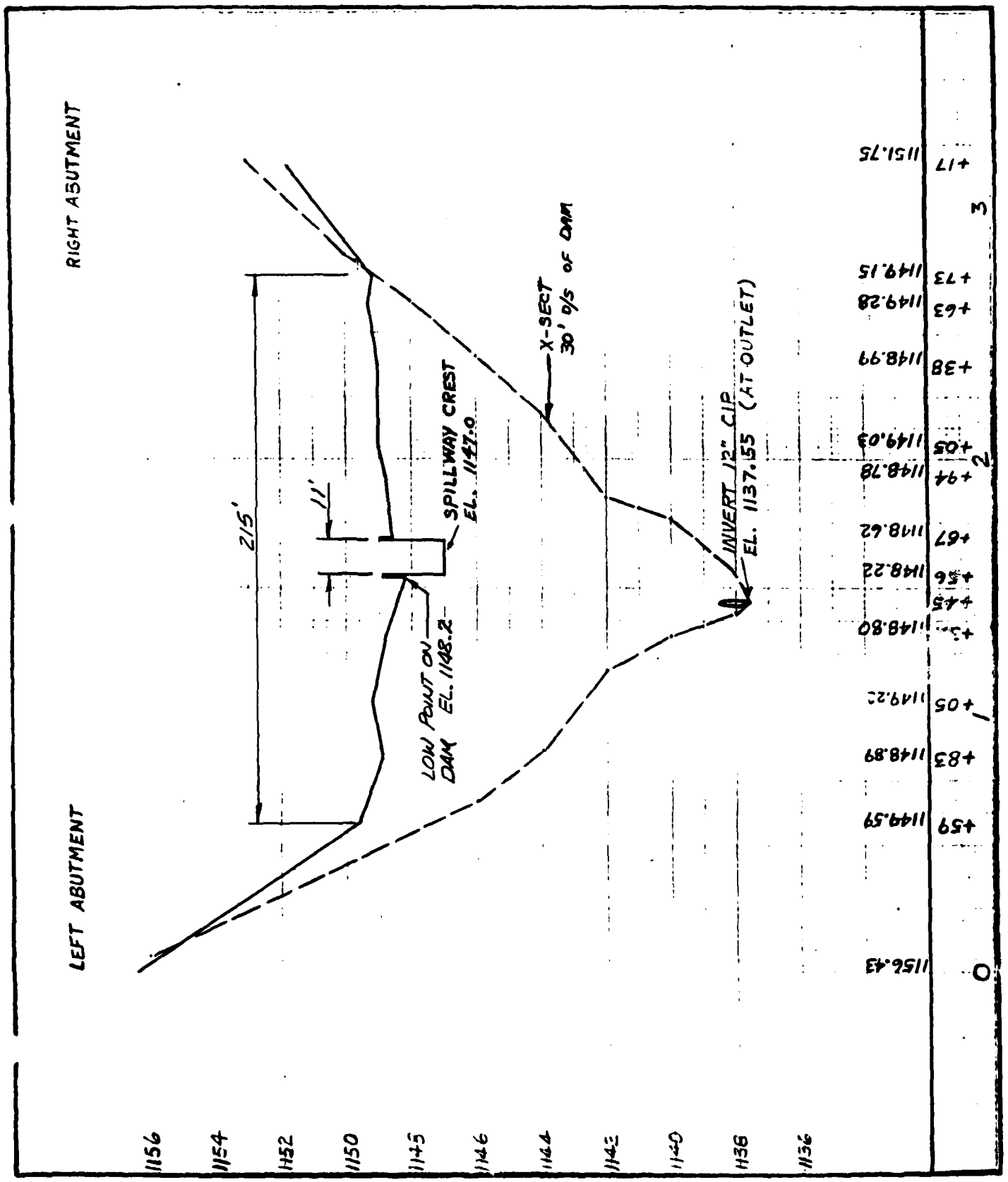
$\Delta E = {}^{3S}/_{A} = (3)(208)/67 = 9.3'$

ELEV. @ 0 AREA = 1147.0 − 9.3' = 1137.7 (CALL 1137.5)

* PENN-DER WATER RESOURCES BULLETIN No. 5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB FORDS LAKE DER 35-64
SHEET NO. 5 OF
CALCULATED BY R.T.M. DATE 1-27-81
CHECKED BY DATE
SCALE HORZ. 1" = 50' VERT. 1" = 4'



GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

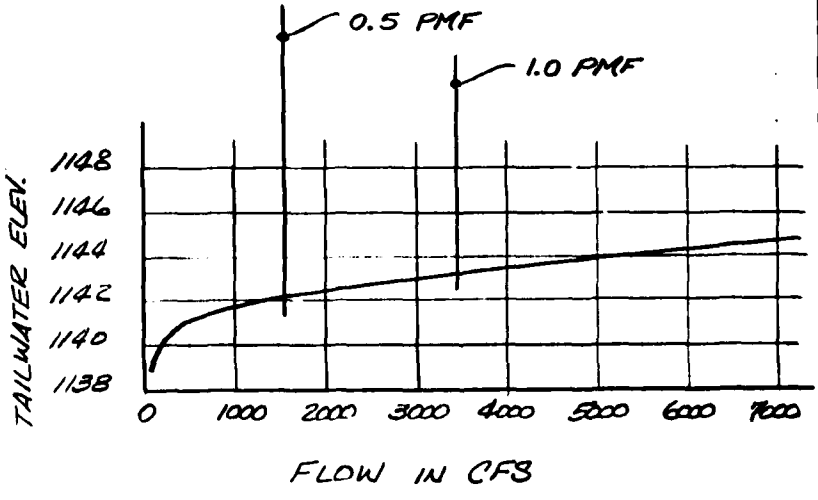
JOB FORD'S LAKE
SHEET NO. 6
CALCULATED BY WEH DATE 2/5/81
CHECKED BY DATE
SCALE

CHECK TAILWATER EFFECT

ASSUME CRITICAL DEPTH @ BREACHED DAM ℄ 150' (SEE NEXT SH.) DOWNSTR. OF FORD'S LAKE DAM.
DOWNSTREAM SLOPE = 2% ∴ NO BACKWATER
TAILWATER @ FORD'S LAKE DAM IS ASSUMED TO BE THE POOL CREATED BY THE BREACHED DAM.

$$\text{TAILWATER} = Y_{\text{CRITICAL}} + V_c^2/2g$$

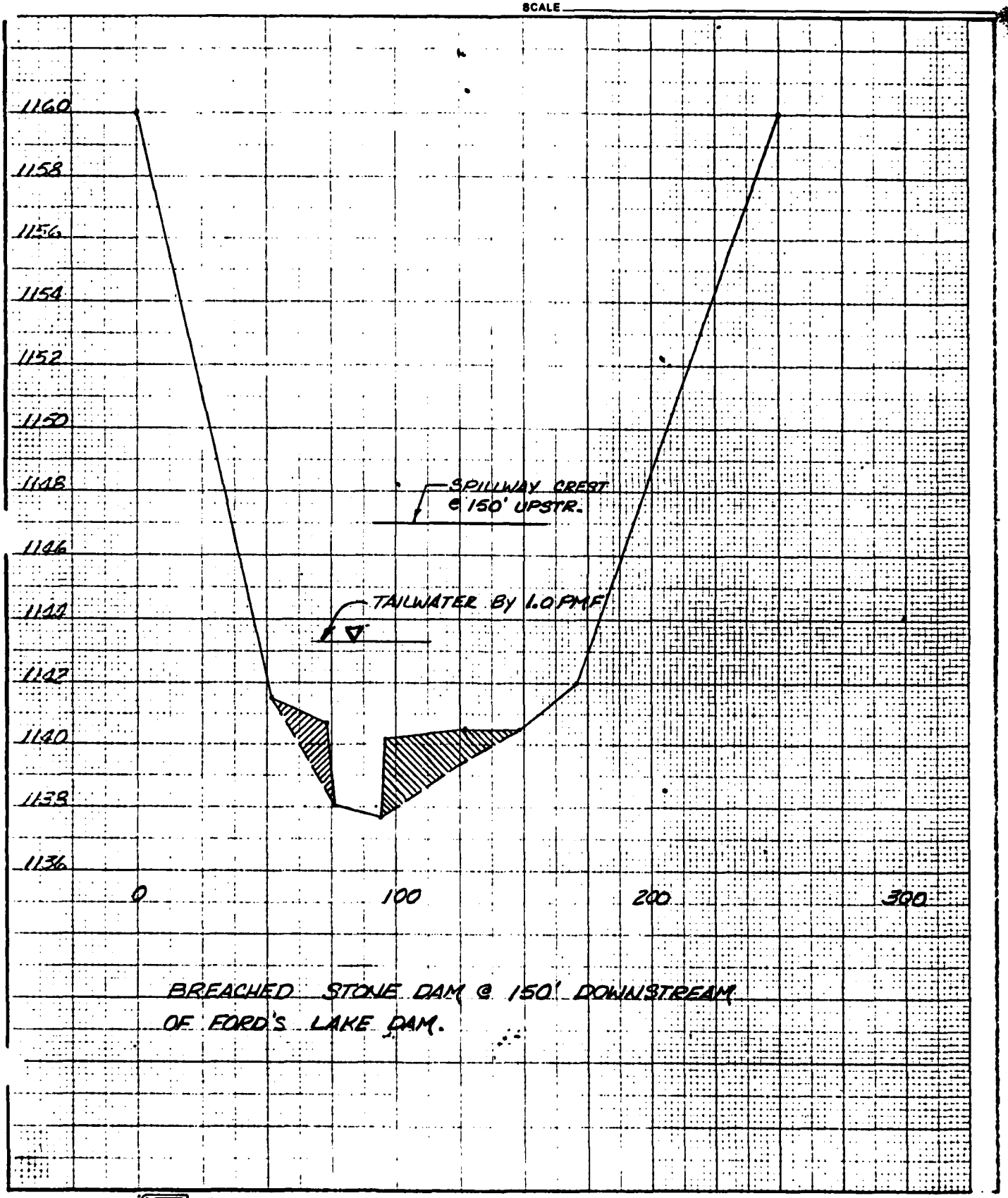
TAILWATER ELEV.	FLOW CFS
1139.0	75
1140.0	259
1141.0	402
1142.0	1322
1143.0	2995
1144.0	5305
1145.0	8270



CONCLUSIONS:
MAX. TAILWATER CAUSED BY 1.0 PMF = ELEV. 1143.3±
FORD'S SPILLWAY CREST ELEV. = 1147.0
∴ TAILWATER DOES NOT AFFECT SPILLWAY / DAM OVERTOPPING

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB FORDS LAKE PA. 298
SHEET NO. 7 OF
CALCULATED BY WEH DATE 2/5/81
CHECKED BY DATE
SCALE



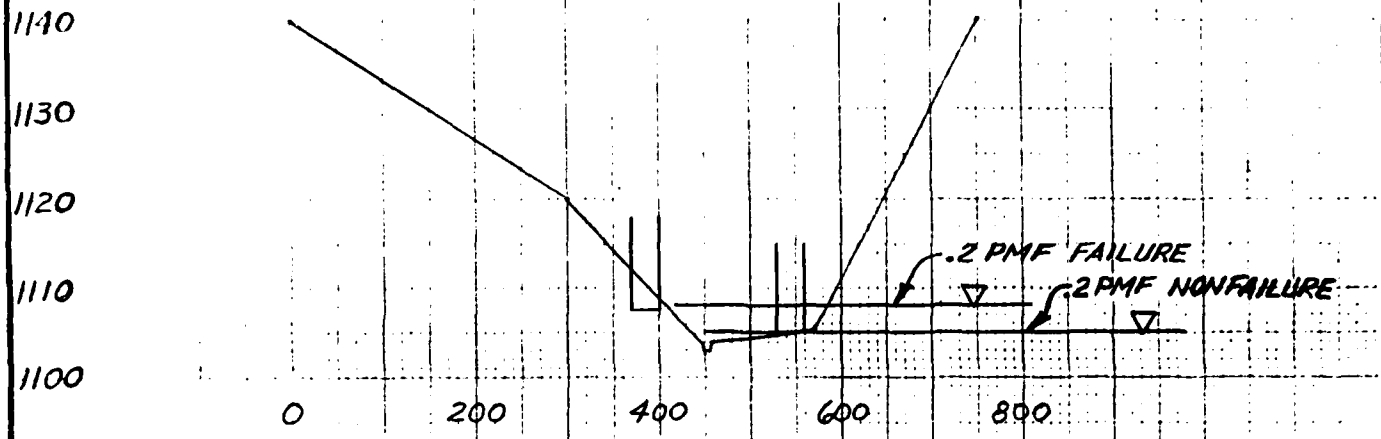
BREACHED STONE DAM @ 150' DOWNSTREAM OF FORD'S LAKE DAM.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB FORD'S LAKE - DNSTR. SECTIONS
SHEET NO 8 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

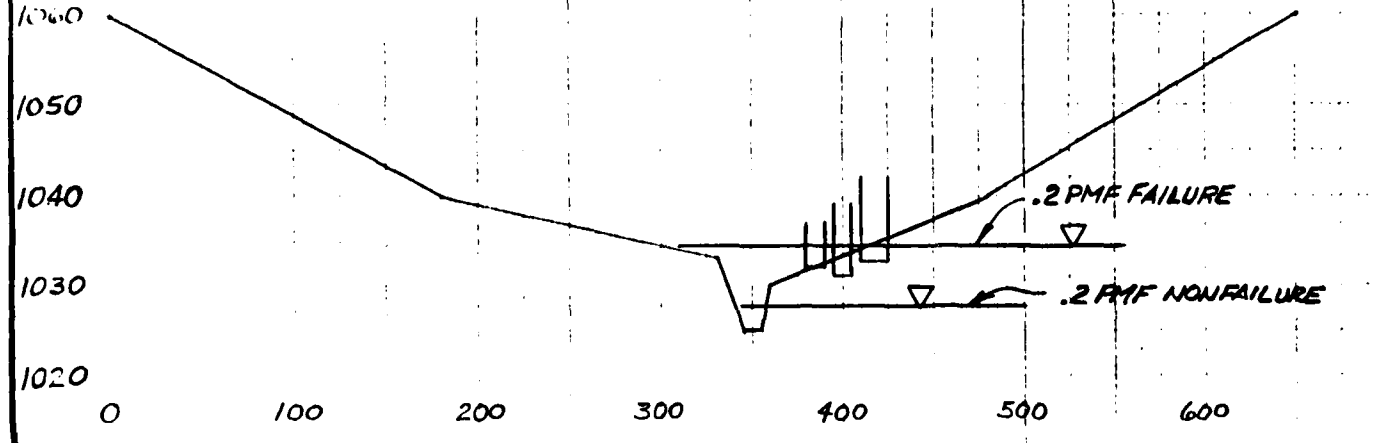
TYPICAL CHANNEL SECTION 3 1100' DOWNSTREAM

2 HOMES WITHIN 100 FEET OF SECTION 3



TYPICAL CHANNEL SECTION 4 4900' DOWNSTREAM

3 HOMES WITHIN 50 FEET OF SECTION 4



GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

DUE TO THE DOWNSTREAM HAZARD CONDITIONS & THE RESULTS OF THE OVERTOPPING ANALYSIS, A BREACH ANALYSIS WILL BE MADE.

THE DAM IS AN EARTH EMBANKMENT WITH A DRY STONE WALL ON A PORTION OF THE DOWNSTREAM FACE. HOWEVER, THE DAM IS IN A DETERIORATED CONDITION, PARTICULARLY IN THE SPILLWAY AREA, & AN OVERTOPPING WOULD CAUSE CONSIDERABLE EROSION DAMAGE & POSSIBLY COMPLETE FAILURE IN THIS AREA.

USE AN OVERTOPPING DEPTH OF 1' AS THE CRITICAL POINT AT WHICH SERIOUS DAMAGE WOULD BEGIN (W.S. ELEV. = 1149.2), BOT OF BREACH ELEV. @ STREAM BED = ELEV. 1137.6, & BREACH SIDE SLOPES OF 1 HOR. ON 1 VERT. INVESTIGATE BREACH WIDTHS OF 15' & 30', EACH WITH FAILURE TIMES OF ½ HOUR.

THE SELECTED SPILLWAY DESIGN FLOOD IS 0.5 PMF, HOWEVER THE SPILLWAY IS NOT CAPABLE OF PASSING EVEV THE 0.2 PMF WITHOUT CAUSING AN OVERTOPPING FAILURE. THEREFORE THE DAM WILL BE ANALYZED TO DETERMINE THE EFFECT ON DOWNSTREAM AREAS DURING BOTH, THE 0.2 PMF & THE 0.5 PMF.

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
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1		A1	NATIONAL DAM INSPECTION PROGRAM								
2		A2	FORD'S LAKE--PA295 (OVERTOPPING ANALYSIS)								
3		A3	NEWTON TWP, LACKAWANNA CO, PA								
4		B	150	0	15	0	0	0	0	0	-4	0
5		B1	5	0	0	0	0	0	0	0	0	0
6		J	1	7	1	0	0	0	0	0	0	0
7		J1	.1	.2	.3	.4	.5	.75	1	0	0	0
8		K	0	1	0	0	0	0	1	0	0	0
9		K1	INFLOW TO RESERVOIR									
10		M	1	1	1.07	0	0	0	0	0	1	0
11		P	0	21.3	118	127	136	142	0	0	0	0
12		T	0	0	0	0	0	0	1	.05	0	0
13		E	0.95	0.62	0	0	0	0	0	0	0	0
4		X	-1.5	-.05	2	0	0	0	0	0	0	0
5		K	1	2	0	0	0	0	1	0	0	0
6		K1	ROUTE THRU RESERVOIR									
7		Y	0	0	0	1	1	0	0	0	0	0
18		Y1	1	0	0	0	0	0	-1147	0	0	0
19		$A	0	67	111	0	0	0	0	0	0	0
20		$E	1137.5	1147	1160	0	0	0	0	0	0	0
21		$S	1147	11	3.0	1.5	0	0	0	0	0	0
22		$D	1148.2	2.7	1.5	265	0	0	0	0	0	0
23		$L	0	87	178	223	280	0	0	0	0	0
24		$V	1148.2	1149	1149.2	1149.6	1151.7	0	0	0	0	0
25		K	1	3	0	0	0	0	1	0	0	0
26		K1	ROUTE TO STREAM SECTION AT STA 3									
27		Y	0	0	0	1	1	0	0	0	0	0
28		Y1	1	0	0	0	0	0	0	0	0	0
29		Y6	.08	.04	.08	1103	1120	1100	.0314	0	0	0
30		Y7	0	1140	300	1120	445	1104	447	1103	453	1103
31		Y7	455	1104	570	1105.5	750	1140	0	0	0	0
32		K	1	4	0	0	0	0	1	0	0	0
33		K1	ROUTE TO STREAM SECTION AT STA 4									
34		Y	0	0	0	1	1	0	0	0	0	0
35		Y1	1	0	0	0	0	0	0	0	0	0
36		Y6	.08	.04	.08	1025	1040	3P00	.0205	0	0	0
37		Y7	0	1060	180	1040	331	1033	345	1025	355	1025
38		Y7	360	1030	480	1040	650	1060	0	0	0	0
39		K	99	0	0	0	0	0	0	0	0	0

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/05/05.
TIME= 09.30.51.

NATIONAL DAM INSPECTION PROGRAM
FORD'S LAKE--PA298 (OVERTOPPING ANALYSIS)
NEWTON TWP, LACKAWANNA CO, PA

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 7 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 .75 1.00

D-14

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SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.07	0.00	1.07	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.20	21.50	11[illegible].00	127.00	136.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .000

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= .[illegible] CP= .62 NTA= 0

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 21 END-OF-PERIOD ORDINATES, LAG= .94 HOURS, CP= .62 VOL= 1.00

24.	194.	352.	447.	418.	308.	246.	142.	134.	102.	
76.	57.	42.	33.	24.	19.	13.	10.	8.	6.	
4.										

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.20	21.97	2.22	60509.
										(615.)	(558.)	(56.)	(1713.42)

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HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSIPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1147.	0

SURFACE AREA=	0.	67.	111.
CAPACITY=	0.	212.	1357.
ELEVATION=	1138.	1147.	1160.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1147.0	11.0	3.0	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1148.2	2.7	1.5	265.

CREST LENGTH	0.	87.	176.	223.	280.
AT OR BELOW ELEVATION	1148.2	1149.0	1149.2	1149.6	1151.7

PEAK OUTFLOW IS 64. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 342. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 737. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1144. AT TIME 41.50 HOURS

D-15

PEAK OUTFLOW IS [illegible] AT TIME 41.00 HOUR

PEAK OUTFLOW IS [illegible] AT TIME 41.00 HOUR

PEAK OUTFLOW IS 3435. AT TIME 41.00 HOURS

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 3

ICTAB	ICSAB	IPROA	ITAPE	JPLT	JPRT	INAME	ICTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IPRS	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

D-16

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	FLNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1103.0	1120.0	1100.	.03140

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1140.00 300.00 1120.00 445.00 1104.00 447.00 1103.00 453.00 1103.00
455.00 1104.00 570.00 1105.50 750.00 1140.00

STORAGE	0.00	.18	1.08	3.67	7.00	10.63	14.54	18.74	23.23	28.01
	33.08	38.43	44.08	50.01	56.23	62.74	69.54	76.63	84.01	91.67
OUTFLOW	0.00	36.16	185.88	666.72	1633.64	2986.15	4706.93	6791.01	9239.09	12055.02
	15244.57	18814.75	22773.38	27126.88	31890.08	37066.07	42666.14	48699.73	55176.36	62105.61
STAGE	1103.00	1103.89	1104.79	1105.68	1106.58	1107.47	1108.37	1109.26	1110.16	1111.05
	1111.95	1112.84	1113.74	1114.63	1115.53	1116.42	1117.32	1118.21	1119.11	1120.00
FLOW	0.00	36.16	185.88	666.72	1633.64	2986.15	4706.93	6791.01	9239.09	12055.02
	15244.57	18814.75	22773.38	27126.88	31890.08	37066.07	42666.14	48699.73	55176.36	62105.61

MAXIMUM STAGE IS 1104.1

MAXIMUM STAGE IS 1105.1

MAXIMUM STAGE IS 1105.7

MAXIMUM STAGE IS 1106.1

MAXIMUM STAGE IS 1106.5

MAXIMUM STAGE IS 1107.1

MAXIMUM STAGE IS 1107.7

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1025.0	1040.0	3800.	.02050

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1060.00 180.00 1040.00 331.00 1033.00 345.00 1025.00 355.00 1025.00
360.00 1030.00 480.00 1040.00 650.00 1060.00

STORAGE	0.00	0.76	1.68	2.74	3.95	5.31	6.82	8.62	11.13	14.38
	18.38	23.54	30.51	39.31	49.93	62.38	76.65	92.75	110.67	130.42
OUTFLOW	0.00	36.40	118.72	241.54	405.40	612.11	863.95	1182.77	1576.96	2054.35
	2628.15	3387.48	4314.66	5432.94	6770.89	8354.37	10207.43	12352.77	14812.05	17606.07
STAGE	1025.00	1025.79	1026.58	1027.37	1028.16	1028.95	1029.74	1030.53	1031.32	1032.11
	1032.89	1033.68	1034.47	1035.26	1036.05	1036.84	1037.63	1038.42	1039.21	1040.00
FLOW	0.00	36.40	118.72	241.54	405.40	612.11	863.95	1182.77	1576.96	2054.35
	2628.15	3387.48	4314.66	5432.94	6770.89	8354.37	10207.43	12352.77	14812.05	17606.07

MAXIMUM STAGE IS 1026.1

MAXIMUM STAGE IS 1027.8

MAXIMUM STAGE IS 1029.3

MAXIMUM STAGE IS 1030.4

MAXIMUM STAGE IS 1031.2

MAXIMUM STAGE IS 1032.7

MAXIMUM STAGE IS 1033.7

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1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 .75	RATIO 7 1.00
HYDROGRAPH AT	1	1.07	1	398.	796.	1194.	1592.	1990.	2986.	3981.
	(	2.77)	(	11.27)(	22.55)(	33.82)(	45.09)(	56.36)(	84.55)(	112.73)(
ROUTED TO	2	1.07	1	64.	342.	737.	1144.	1549.	2500.	3438.
	(	2.77)	(	1.81)(	9.68)(	20.88)(	32.40)(	43.85)(	70.78)(	97.35)(
ROUTED TO	3	1.07	1	64.	341.	735.	1145.	1548.	2495.	3434.
	(	2.77)	(	1.81)(	9.64)(	20.82)(	32.43)(	43.84)(	70.65)(	97.25)(
ROUTED TO	4	1.07	1	64.	341.	735.	1149.	1542.	2495.	3404.
	(	2.77)	(	1.81)(	9.66)(	20.81)(	32.53)(	43.65)(	70.65)(	96.38)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1147.00	1147.00	1148.20
STORAGE	212.	212.	295.
OUTFLOW	0.	0.	43.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1148.47	.27	314.	64.	6.75	43.50	0.00
.20	1149.37	1.17	379.	342.	8.25	42.50	0.00
.30	1149.83	1.63	414.	737.	9.00	41.75	0.00
.40	1150.18	1.98	441.	1144.	9.75	41.50	0.00
.50	1150.49	2.29	464.	1548.	10.00	41.25	0.00
.75	1151.09	2.89	511.	2500.	10.75	41.00	0.00
1.00	1151.59	3.39	552.	3438.	11.25	41.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	64.	1104.1	43.75
.20	341.	1105.1	42.50
.30	735.	1105.7	41.75
.40	1145.	1106.1	41.50
.50	1548.	1106.5	41.25
.75	2495.	1107.1	41.00
1.00	3434.	1107.7	41.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	64.	1026.1	43.75
.20	341.	1027.8	42.75
.30	735.	1029.3	41.75
.40	1149.	1030.4	41.50
.50	1542.	1031.2	41.25
.75	2495.	1032.7	41.25
1.00	3404.	1033.7	41.25

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
 LAST MODIFICATION  01 APR 80
**********
    1          A1    NATIONAL DAM INSPECTION PROGRAM
    2          A2    FORD'S LAKE--PA298 (BREACH ANALYSIS)
    3          A3    NEWTON TWP, LACKAWANNA CO, PA
    4          B   150     0      15      0       0       0       0       0      -4       0
    5          B1    5     0       0      0       0       0       0       0       0       0
    6          J     2     2       1      0       0       0       0       0       0       0
    7          J1   .2    .5       0      0       0       0       0       0       0       0
    8          K     0     1       0      0       0       0       1       0       0       0
    9          K1      INFLOW TO RESERVOIR
   10          H     1     1    1.07      0       0       0       0       0       1       0
   11          P     0  21.3     118    127     136     142       0       0       0       0
   12          T     0     0       0      0       0       0       1     .05       0       0
   13          W  0.95  0.62       0      0       0       0       0       0       0       0
   14          X  -1.5  -.05       2      0       0       0       0       0       0       0
   15          K     1     2       0      0       0       0       1       0       0       0
   16          K1      ROUTE THRU RESERVOIR
   17          Y     0     0       0      1       1       0       0       0       0       0
   18          Y1    1     0       0      0       0       0   -1147       0       0       0
   19          SA    0    67     111      0       0       0       0       0       0       0
   20          SE1137.5  1147    1160      0       0       0       0       0       0       0
   21          SS  1147    11     3.0    1.5       0       0       0       0       0       0
   22          SD1148.2   2.7     1.5    265       0       0       0       0       0       0
   23          SL    0    87     178    223     280       0       0       0       0       0
   24          SV1148.2  1149  1149.2 1149.6  1151.7       0       0       0       0       0
   25          SR   15     1  1137.6     .5    1147  1149.2       0       0       0       0
   26          SB   30     1  1137.6     .5    1147  1149.2       0       0       0       0
   27          K     1     3       0      0       0       0       1       0       0       0
   28          K1      ROUTE TO STREAM SECTION AT STA 3
   29          Y     0     0       0      1       1       0       0       0       0       0
   30          Y1    1     0       0      0       0       0       0       0       0       0
   31          Y6  .08   .04     .08   1103    1120    1100   .0314       0       0       0
   32          Y7    0  1140     300   1120     445    1104     447    1103     453    1103
   33          Y7  455  1104     570 1105.5     750    1140       0       0       0       0
   34          K     1     4       0      0       0       0       1       0       0       0
   35          K1      ROUTE TO STREAM SECTION AT STA 4
   36          Y     0     0       0      1       1       0       0       0       0       0
   37          Y1    1     0       0      0       0       0       0       0       0       0
   38          Y6  .08   .04     .08   1025    1040    3800   .0205       0       0       0
   39          Y7    0  1060     180   1040     331    1033     345    1025     355    1025
   40          Y7  360  1030     480   1040     650    1060       0       0       0       0
   41          K    99     0       0      0       0       0       0       0       0       0
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/05/06.
TIME= 09.33.44.

NATIONAL DAM INSPECTION PROGRAM
FORD'S LAKE--PA298 (BREACH ANALYSIS)
NEWTON TWP, LACKAWANNA CO, PA

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

12-0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 2 LRTIO= 1

RTIOS= .20 .50

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SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.07	0.00	1.07	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.30	118.00	127.00	136.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .95 CP= .62 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 21 END-OF-PERIOD ORDINATES, LAG= .94 HOURS, CP= .62 VOL= 1.00

54.	194.	353.	447.	419.	325.	243.	182.	136.	102.
76.	57.	43.	32.	24.	18.	13.	10.	8.	6.
4.									

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
		SUM	24.20	21.97	2.22	60509.
			(615.)	(558.)	(56.)	(1713.42)

MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

D-22

ROUTE THRU RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1147.	0

SURFACE AREA=	0.	67.	111.
CAPACITY=	0.	212.	1357.
ELEVATION=	1138.	1147.	1160.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1147.0	11.0	3.0	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1148.2	2.7	1.5	265.

CREST LENGTH	0.	87.	178.	223.	280.
AT OR BELOW ELEVATION	1148.2	1149.0	1149.2	1149.6	1151.7

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
15.	1.00	1137.60	.50	1147.00	1149.20

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 2889. AT TIME 42.00 HOURS

BEGIN DAM FAILURE AT 39.50 HOURS

PEAK OUTFLOW IS 3149. AT TIME 40.00 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
30.	1.00	1137.60	.50	1147.00	1149.20

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 4423. AT TIME 42.00 HOURS

BEGIN DAM FAILURE AT 39.50 HOURS

PEAK OUTFLOW IS 4710. AT TIME 40.00 HOURS

D-23

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1103.0	1120.0	1100.	.03140

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1140.00 300.00 1120.00 445.00 1104.00 447.00 1103.00 453.00 1103.00
455.00 1104.00 570.00 1105.50 750.00 1140.00

STORAGE	0.00	.18	1.08	3.67	7.00	10.63	14.54	18.74	23.23	28.01
	33.08	38.43	44.08	50.01	56.23	62.74	69.54	76.63	84.01	91.67
OUTFLOW	0.00	36.16	185.99	666.72	1633.64	2986.15	4706.93	6791.01	9239.09	12055.02
	15244.57	18814.75	22773.38	27128.88	31890.08	37066.07	42666.14	48699.73	55176.36	62105.61
STAGE	1103.00	1103.89	1104.79	1105.68	1106.58	1107.47	1108.37	1109.26	1110.16	1111.05
	1111.95	1112.84	1113.74	1114.63	1115.53	1116.42	1117.32	1118.21	1119.11	1120.00
FLOW	0.00	36.16	185.99	666.72	1633.64	2986.15	4706.93	6791.01	9239.09	12055.02
	15244.57	18814.75	22773.38	27128.88	31890.08	37066.07	42666.14	48699.73	55176.36	62105.61

MAXIMUM STAGE IS 1107.4

42-0

MAXIMUM STAGE IS 1107.6

MAXIMUM STAGE IS 1108.1

MAXIMUM STAGE IS 1108.3

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1025.0	1040.0	3800.	.02050

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1060.00 180.00 1040.00 331.00 1033.00 345.00 1025.00 355.00 1025.00
360.00 1030.00 480.00 1040.00 650.00 1060.00

STORAGE	0.00 18.38	0.76 23.54	1.68 30.51	2.74 39.31	3.95 49.93	5.31 62.38	6.82 76.65	8.62 92.75	11.13 110.67	14.38 130.42
OUTFLOW	0.00 2628.15	36.40 3387.48	118.72 4314.66	241.54 5432.94	405.40 6770.89	612.11 8354.37	863.95 10207.43	1182.77 12352.77	1576.96 14812.05	2054.35 17606.07
STAGE	1025.00 1032.89	1025.79 1033.68	1026.58 1034.47	1027.37 1035.26	1028.16 1036.05	1028.95 1036.84	1029.74 1037.63	1030.53 1038.42	1031.32 1039.21	1032.11 1040.00
FLOW	0.00 2628.15	36.40 3387.48	118.72 4314.66	241.54 5432.94	405.40 6770.89	612.11 8354.37	863.95 10207.43	1182.77 12352.77	1576.96 14812.05	2054.35 17606.07

MAXIMUM STAGE IS 1033.1
MAXIMUM STAGE IS 1033.4
MAXIMUM STAGE IS 1034.4
MAXIMUM STAGE IS 1034.7

********** ********** ********** ********** **********

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .50
HYDROGRAPH AT	1	1.07	1	796.	1990.
		(2.77)		(22.55)(	56.36)(
			2	796.	1990.
				(22.55)(	56.36)(
ROUTED TO	2	1.07	1	2889.	3149.
		(2.77)		(81.80)(	89.16)(
			2	4423.	4710.
				(125.24)(	133.38)(
ROUTED TO	3	1.07	1	2835.	3161.
		(2.77)		(80.27)(	89.50)(
			2	4143.	4557.
				(117.30)(	129.05)(
ROUTED TO	4	1.07	1	2839.	3149.
		(2.77)		(80.40)(	89.17)(
			2	4240.	4594.
				(120.06)(	130.08)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1147.00	1147.00	1148.20
STORAGE	212.	212.	295.
OUTFLOW	0.	0.	43.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1149.25	1.05	371.	2889.	2.50	42.00	41.50
.50	1149.43	1.23	384.	3149.	2.75	40.00	39.50

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1147.00	1147.00	1148.20
STORAGE	212.	212.	295.
OUTFLOW	0.	0.	43.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1149.24	1.04	370.	4423.	2.34	42.00	41.50
.50	1149.40	1.20	382.	4710.	2.24	40.00	39.50

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2835.	1107.4	42.25
.50	3161.	1107.6	40.25

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	4143.	1108.1	42.25
.50	4557.	1108.3	40.25

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2839.	1033.1	42.25
.50	3149.	1033.4	40.25

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	4240.	1034.4	42.25
.50	4594.	1034.7	40.25

D-28

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  01 APR 80
 **********************************
 EOI ENCOUNTERED.
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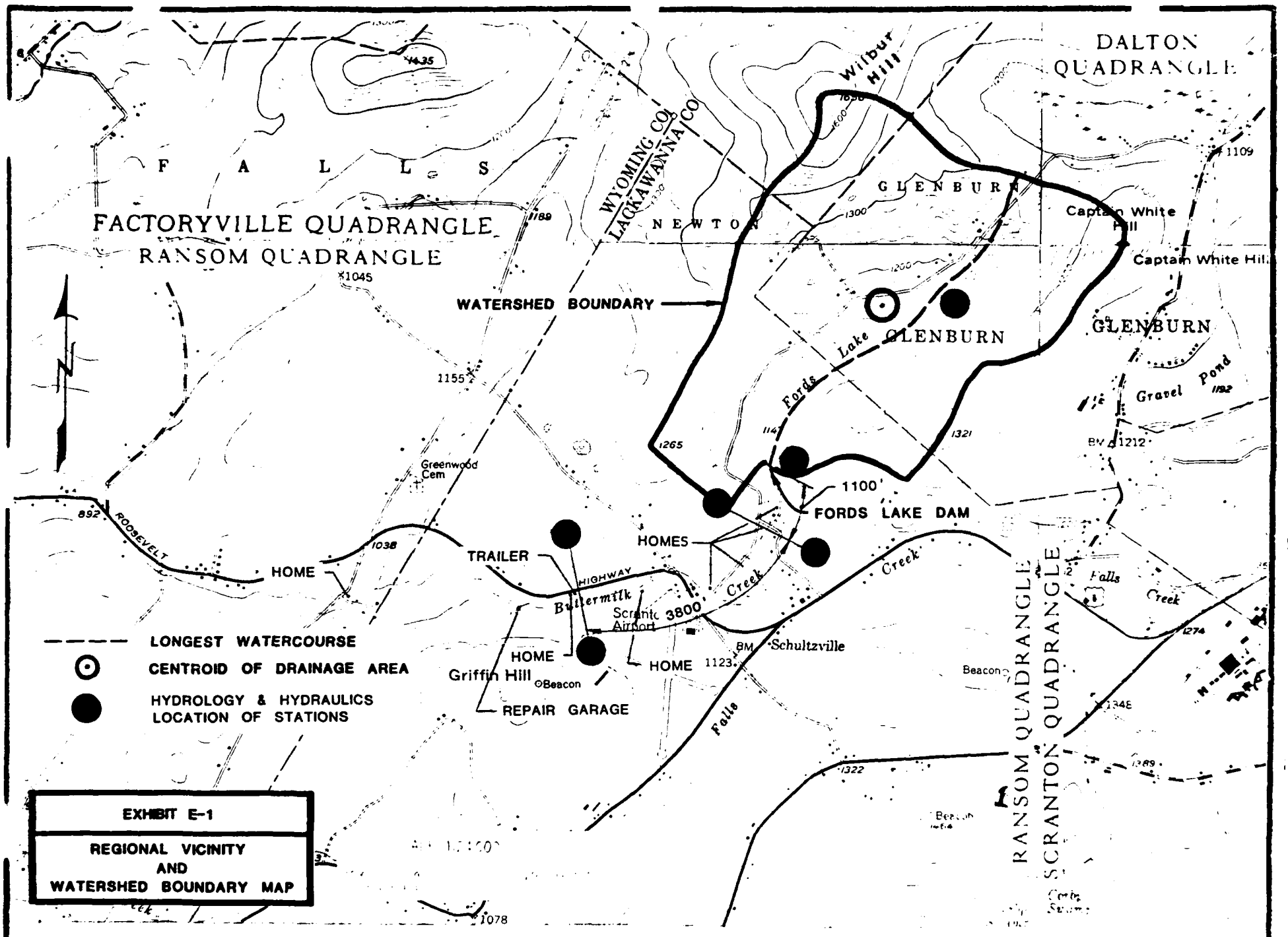
APPENDIX E

EXHIBITS


DALTON QUADRANGLE
FACTORYVILLE QUADRANGLE
RANSOM QUADRANGLE
SCRANTON QUADRANGLE
F A L L S
NEWTON
GLENBURN
WYOMING CO
LACKAWANNA CO
Wilbur Hill
Captain White Hill
Captain White Hill
GLENBURN
Lake GLENBURN
Fords Lake
Gravel Pond
WATERSHED BOUNDARY
1100'
FORDS LAKE DAM
HOMES
TRAILER
HOME
HOME
HOME
REPAIR GARAGE
Griffin Hill
Beacon
Schultzville
Scranton Airport
Greenwood Cem
ROOSEVELT
HIGHWAY
Buttermilk Creek
Falls Creek
Falls Creek
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
HYDROLOGY & HYDRAULICS
LOCATION OF STATIONS
EXHIBIT E-1
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP

APPENDIX F

GEOLOGY

FORD'S LAKE DAM

APPENDIX F

GEOLOGY

The Ford's Lake Dam and reservoir area are located within the Glaciated Allegheny Plateau Section of the Appalachian Plateau Physiographic Province. The site is about 8 miles northwest of the axis of the Northern Anthracite Field of Pennsylvania. Deposits of glacial drift of variable thickness covers the entire area. The drift was deposited by the Wisconsin Ice Sheet during the Pleistocene period of geologic time.

The glacial drift is composed primarily of till which is reddish brown, unsorted, compact mixture of clay, silt, sand, gravel, and cobbles with occasional boulder size pieces. The stone pieces are sub-angular to rounded and consist mainly of sandstone and siltstone derived from the Catskill Formation, the dominant rock formation in the area. The clay content and compact nature of the till makes it a relatively impervious soil type.

Some deposits of glacial outwash and Kame terraces are also found in the area. These deposits are composed of loose, poorly sorted to stratified deposits of silt, sand, and gravel. The Kame and outwash deposits are generally very pervious. A hand-dug well (E.H. Stanton) about 2500 feet west of the dam site, penetrated 31 feet of outwash deposits.

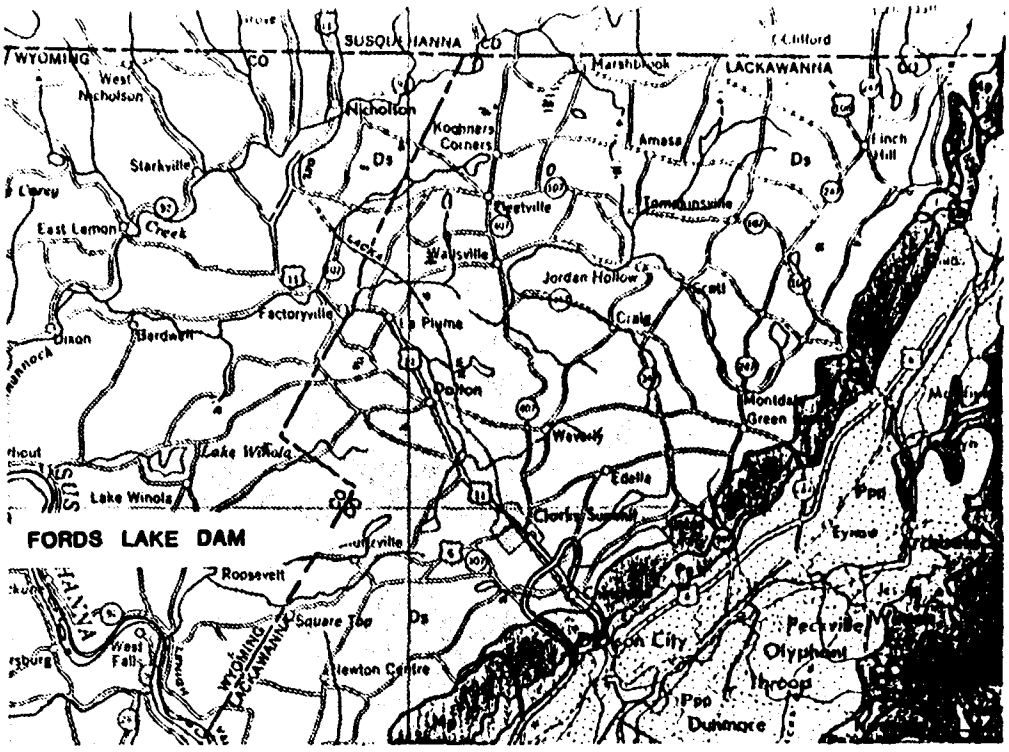
Other loose pervious soils in the area are the recent deposits of alluvial silt, sand, and gravel with some clay. These soils are localized and limited to streambeds and flood plain areas. The flat, marshy area at the upstream end of the lake contains such alluvial desposits.

The bedrock underlying the entire dam and reservoir area is the Catskill Formation of the Susquehanna Group. This group of formations is of Upper Devonian age. The Catskill strata generally consists of well indurated, red shale, siltstone and fine sandstone with some gray, green, and brown shale, siltstone and sandstone layers. Occasional conglomeratic layers are encountered. The red shales are the dominant lithology and the residual soils derived from this rock are usually high in clay and silt and contain numerous flaky and angular fragments and flat, slabby boulders. The hillside left of the dam and reservoir areas is covered with many such flat, slabby boulders and the dry masonry walls of the dam itself are constructed from similar one and two-man sized boulders.

The regional structure of the bedrock in the area indicates that the bedrock underlying the dam and reservoir area is gently folded (dip 1^{o}NW) to near-horizontal. The regional strike of the folds is N 55^{o}E.

Although depth to bedrock at the dam site is unknown, the steep earth slopes about 500 feet downstream of the dam and the hand-dug well to the west indicates at least 30 feet of overburden soil.

Ref.: Ground Water of Northeastern Pennsylvania, Stanley W. Lohman, 1937; Bulletin W-4, Pennsylvania Geologic Survey



0 1 2 3 4 5 10 MILES

SCALE: 1" = 4 MILES

LEGEND

PENNSYLVANIAN

ANTHRACITE REGION

Post-Pottsville Formations
Brown or gray sandstones and shales with some conglomerate and numerous minable coals.

Pottsville Group
Light gray to white, coarse grained sandstones and conglomerates with some minable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mauch Chunk Formation
Red shales with brown to greenish gray flaggy sandstones, includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group
Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale, includes in the Appalachian Plateau Region, Shenango, Cuyahoga, Corry and Knapp Formations; includes part of "Oswayo" of A. J. Butler in Potter and Tioga counties

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Oswayo Formation
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses, includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Catskill Formation
Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Pike Mountain, Honesdale, Shohola, and Delaware River in the east.

Marine beds
Gray to olive brown shales, graywackes, and sandstones, contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Susquehanna Group
Dashed line in "Chemung Catskill" contact of Second Pennsylvania Survey County reports, herein "Chemung" side of line.

NOTE:
GEOLOGIC MAP AND LEGEND OBTAINED FROM GEOLOGIC MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1960

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

FORDS LAKE DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

FEBRUARY 1981

EXHIBIT F